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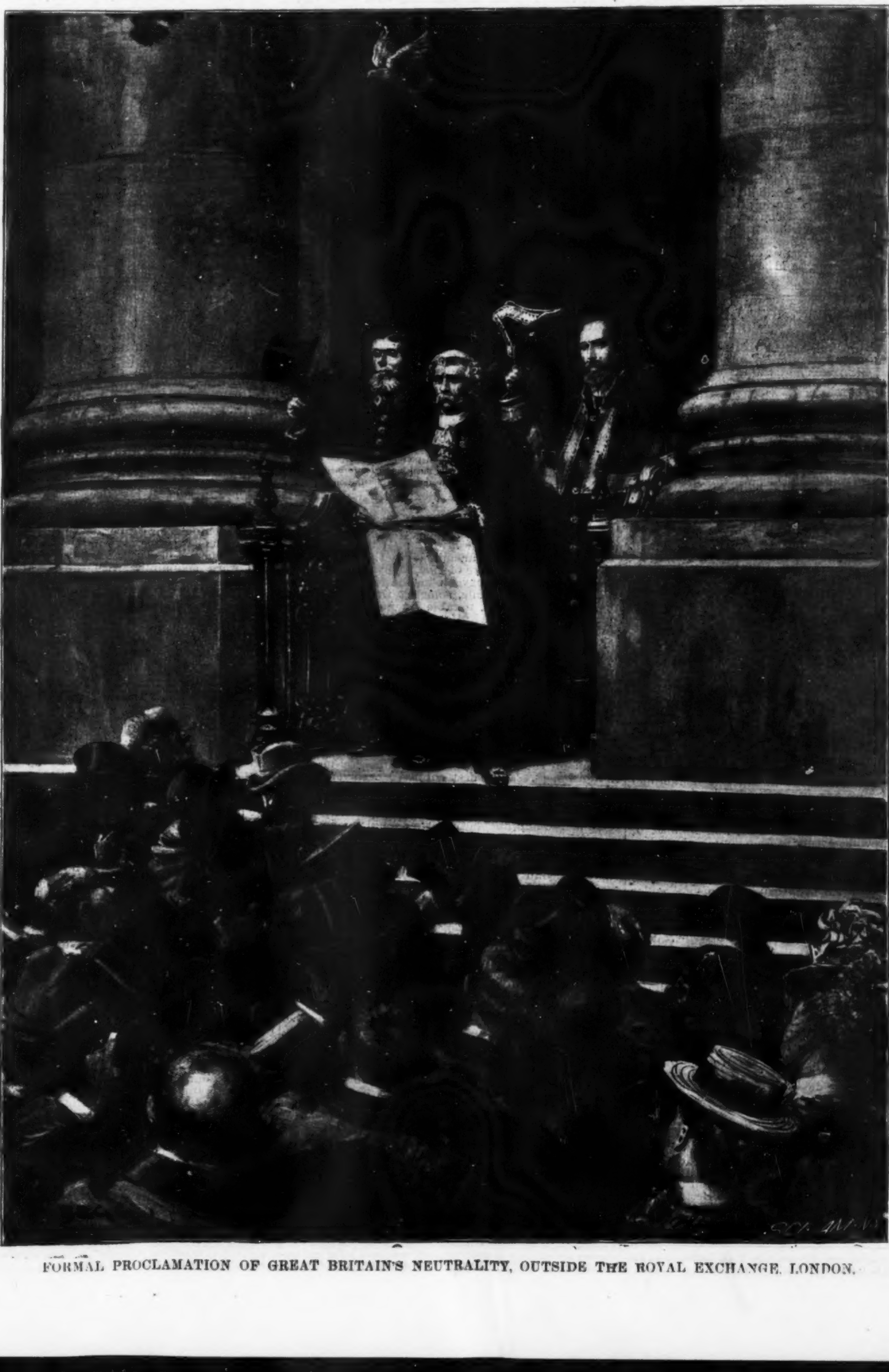

FORMAL PROCLAMATION OF GREAT BRITAIN'S NEUTRALITY, OUTSIDE THE ROYAL EXCHANGE, LONDON.

GREAT BRITAIN'S NEUTRALITY.

OUR engraving, for which we are indebted to The Illustrated London News, shows the Common Crier Col. Burnaby reading the proclamation of Great Britain's neutrality outside the Royal Exchange, London. The government of the United States was greatly pleased over the prompt declaration of neutrality which England promulgated on April 24. It disposed of embarrassing questions regarding the right of the United States to seize the "Buena Ventura" and other Spanish merchantmen before war had been formally declared by the Spanish ministry or the American Congress. It was not then necessary for Congress to declare war, although a formal declaration of war followed in due course. With Great Britain setting the example, proclamations of neutrality by other nations of the world followed quickly. Notice of the proclamation was posted ordering American warships to leave British ports within a specified time. The decision of Great Britain rendered it impossible for the United States to secure the services of the "Albany" and the "Somers" before the end of the war, but it was considered that these drawbacks were of very minor importance. Great Britain's declaration that a state of war existed and her consequent notice to American vessels to leave British ports caused great and important changes in the strategical situation, forcing the United States to begin its contemplated offensive movements against the Philippines at once. The Prince of Wales presided at a meeting of the Privy Council in behalf of the Queen on April 24. The meeting was held at Marlborough House and was called for the purpose of approving a draft of a proclamation of neutrality. The Duke of Devonshire, President of the Council, and Viscount Cross, Lord Privy Seal, were present.

The prompt declaration of neutrality by England was favorably received all over the United States, and it was regarded as showing the friendliest kind of feelings and helps to cement the ties which we have with England. The increase of cordiality between the United States and England during the present war is gratifying in the extreme. The Washington correspondent of The Daily Mail cables that in an interview President McKinley said: "Not the government alone, but the whole nation, feel most deeply the good will sent to them across the sea," and he added impressively, "nor will they forget it."

THE METALS USED BY THE GREAT NATIONS OF ANTIQUITY.*

AT the beginning of this century little was known of the great nations of antiquity, except through the classic poets and historians and the sacred writings of the Hebrew people. Since then our knowledge has been enormously increased by the labors of scholars and explorers; the ruins of ancient cities have been exhumed, and the contemporary literature of Egypt and Assyria, inscribed on papyri or tablets of clay and painted or carved on the walls of temples, palaces and tombs, has been deciphered. What is in some respects still more important is that objects found in these ruins have thrown great light upon the daily life of the people and their ornamental and useful arts. One of the departments of this inquiry concerns the metals used by the different nations and at the different epochs of their history; and it is to this that my attention will be confined this evening. The difficulty I experience is the vast amount of material, and I cannot attempt anything more than a general view of the subject and some of the most salient points.

The area over which the inquiry extends is that of the lands bordering on the eastern half of the Mediterranean and stretching eastward to the Persian Gulf. The time, so far as Egypt is concerned, includes the whole period from the first Pharaoh, Menes, to the conquest of the country by Alexander the Great, ranging from about B. C. 4400 to B. C. 332. The chronology employed throughout is that of Dr. Wallis Budge, of the British Museum, who has adopted in the main that of Brugsch Bey. This period of 4,000 years appears to me reasonable, and errs, if anything, on the side of moderation. Our knowledge of the other nations does not extend to anything like so remote a time.

EGYPT.

If we take as our starting point Seneferu's triumphal tablet in Wady Maghara, in the Sinaitic Peninsula, we see the king flourishing his battleax over the head of his enemy. This symbolizes the conquest of the copper and turquoise mines of that region, and implies, of course, their previous existence as a source of wealth. In the hieroglyphic inscription above his head there is not only the king's name spelt phonetically, but in the royal titles are seen two ideographs which bear upon our subject. One is the necklace or ornamental collar which is the well known symbol for gold, and the other an ax, the head of which resembles rather that of a copper than of a stone weapon. These titles have no reference to the metals themselves, but mean "Golden Horus" and "Beneficent Divinity." Before such symbols could be used to express abstract ideas they must have been well known in their concrete form. The date assigned to Seneferu is B. C. 3750; but the discoveries of the past year have put in our possession the actual metals themselves, of a much greater antiquity. M. de Morgan, late director general of antiquities in Egypt, has explored an enormous royal tomb at Nagada, the center chamber of which contained the mummy of the Pharaoh, with the cartouche of King Menes, the reputed first king of Egypt. If it be really his tomb, the probable date will be B. C. 4400. What is interesting to us is that in two of the chambers, among a multitude of articles made of ivory, quartz, porphyry, wood, alabaster, tortoiseshell, mother-of-pearl, obsidian, earthenware, cornelian, glass and cloth, there were found some small pieces of metal, viz., two or three morsels of gold and a long bead of that metal of a somewhat crescent form, together with some articles of copper—a kind of button, a bead and some fine wire. The button was analyzed by M. Berthelot, the well known French chemist and politician, to whom we are indebted for the examination of a very large number of ancient metallic objects; he states that it is nearly pure copper, without arsenic or any other metal in notable proportion.

These are the oldest metallic objects in the world to which we can assign a probable date. But Prof. Flinders Petrie had discovered three years ago, also at Nagada, a great number of objects of the same character, and among them a few small copper implements. Some filings from a dagger, a celt and a little harpoon were analyzed by me, and found to consist of practically pure copper, without any trace of tin. The remains of these filings are in the little bottles on the table. The age of these tools must be comparable with that of the royal tomb, and may possibly be even older.

Of about the same period, and perhaps even earlier, are a number of tombs at and near Abydos, which have been explored by M. Amélineau, bearing the names of kings unknown to history, accompanied by hieroglyphics of archaic form. In these have been found larger quantities of copper utensils, viz., pots, hatchets, needles, chisels, etc., which M. Berthelot also finds to be nearly pure metal, but some contain a little arsenic. It would appear, therefore, that the Egyptians at the very beginning of the historic period were acquainted with the use of gold and copper. Let us follow the history of these two metals, beginning with gold, which, as it is generally found native, was probably the first known to man.

According to a letter just received by me from M. Berthelot, all or nearly all the ancient gold that he has examined contains more or less silver. This pale colored gold is sometimes termed electrum, and was found in great quantity in Asia Minor, where the Pactolus and other streams "rolled down their golden sands." Gold is frequently represented in the Egyptian sculptures and pictures; for instance, in the very interesting scenes of social life at Beni Hassan, circa B. C. 2400, illustrations of which I now throw upon the screen, we see the goldsmiths making jewelry, weighing out the metal, melting it in their little furnaces with the aid of blowpipe and pincers, washing it and working it into the proper forms. In the picture of a bazar at Thebes we find a lady bargaining for a necklet; and in another picture we see the weighing of thick rings of gold and of silver, which were used as articles of exchange. I wish I could show you the exquisite gold jewelry, inlaid with gems, found in the tombs of four princesses buried at Dahshur about B. C. 2350, and which is now exhibited in the museum of Gizeh; but I can throw upon the screen the photograph of the beautiful enameled gold necklace of Queen Ahhotpu, B. C. 1700. The great kings Seti I. and Rameses II., B. C. 1300, worked extensive gold mines in Nubia, which yielded gold free from silver.*

To return to the history of copper. In the inscriptions we cannot distinguish between copper and its various alloys, for they are all expressed by the general term chemt and the symbol of the battleax blade. But if we can get the substance itself and analyze it, we know what we are dealing with. Many specimens of copper implements dating from the fourth to sixth dynasty, say B. C. 3750 to 3100, have been examined. They consist of almost pure copper. One of the earliest, analyzed by me, was a piece of a vessel from El Kab, which contained 98 per cent. of copper, the remaining 2 per cent. being made up of bismuth, arsenic, lead, iron, sulphur and oxygen, evidently the impurities in the original ore.

It was evidently very important for the Egyptians to harden the copper as much as possible; and this might be effected in several ways: (1) by hammering, (2) by the admixture of arsenic, (3) by the admixture of tin, (4) by the admixture of zinc, (5) by the presence of a certain amount of oxygen in the form of cuprous oxide. As to the arsenic, some of the oldest copper implements contain a notable quantity. Dr. Percy found 2·29 per cent. in a knife which was dug up some distance below a statue of Rameses II.; and I found 3·9 per cent. in a hatchet from Kahun, dating back to B. C. 2300. It is said, however, that the addition of 0·5 per cent. of arsenic is sufficient to produce a hardening effect; and many specimens of ancient copper implements contain this amount, though the proportion of arsenic in copper ores themselves rarely exceeds 0·1 per cent.

As to the mixture of tin. It is well known that bronze, the alloy of copper and tin, is stronger than pure copper. The extent of this depends upon the proportion of the two metals, and probably on other circumstances. The oldest supposed occurrence of an admixture of tin is in a bronze rod found by Flinders Petrie in a mastaba at Medum, probably of the fourth dynasty, which I found to contain 9·1 per cent. of tin. It seemed so improbable that tin should be employed at so remote a period, and that in sufficient quantity to make what we call gun metal, that I was suspicious of its genuineness, notwithstanding the very circumstantial account of its discovery; but M. Berthelot has since found in a ring from a tomb at Dahshur, believed to be not much later than the third dynasty, 8·2 per cent. of tin; and in a vase of the sixth dynasty, 5·68 per cent. of tin. These seem to restore the credit of Dr. Petrie's specimen. At a later period weak bronzes become common. Thus, at Kahun tools found in a carpenter's basket by Prof. Petrie contain varying amounts of tin from 0·5 to 10·0 per cent.; 6 or 7 per cent. of tin was subsequently common. Bronze implements abound in Egypt. I am able not only to throw upon the screen representations of arrow and spear heads and battleaxes, but, through the kindness of Sir John Evans, to show a beautiful large spear head with an inscription of King Kames (B. C. 1750) down the blade. I am also indebted to Prof. Flinders Petrie and Dr. Walker for this collection of implements of the twelfth dynasty from Illahun, including a fine mirror with ivory handle, necklets, and a bronze casting for a knife which was never finished; also many objects of the eighteenth dynasty, or thereabouts, such as a sword, dagger and ax, together with mirrors, bracelets, earrings and pendants, and a steelyard. My own collection contains specimens of what are believed to be razors of different types, and small statuettes.

As to the admixture of zinc. There does not seem to be any specimen of brass, properly so called, found in Egypt within the period of our inquiry; but various attempts are known to have been made to imitate gold, of which aurochalcum is an instance, and that may have been yellow brass.

As to oxygen. It is generally supposed to exist in copper in the form of the red cuprous oxide; and most of the copper and many of the bronze implements have a covering of this substance. This is caused by the gradual formation of an oxychloride of copper through the action of alkaline chlorides in the soil, aided by the air and moisture. Berthelot has worked out the chemistry of this substance very fully, and shows how when once formed it gradually works its way into the solid metal, transforming it into the suboxide, and frequently disintegrating it. Some good specimens of little bronze images suffering this disintegration are exhibited by Mr. Joseph Offord. Two at least of the copper adzes on the table consist to the extent of 30 or more per cent. of oxide of copper. They are exceedingly hard, and it becomes a question whether the formation of the oxide is due to the slow chemical change or whether it was purposely produced in the manufacture in order to harden them. The effect of different proportions of oxygen on the tenacity of copper is known to be very various, and certainly deserves further investigation.

It is difficult, or rather impossible, to express in definite figures the advantage gained by the ancient Egyptian metallurgists through this alloying of the copper. Arsenic, tin or zinc may and do affect the hardness or the tenacity, or the elasticity, in different ways, and also according to the proportion of the metal united with the copper. Thus there are several very different kinds of alloys of copper and tin, though they are all included under the name of bronze; moreover, a piece of copper which has been exposed to a considerable stress is permanently altered in its properties. Again, in any table of numerical values it should be taken into account whether the copper with which the alloys are compared had been made as pure as possible or contained a normal amount of oxygen.* We must rest contented with the knowledge that copper can be rendered stronger and more serviceable by these means, and that the ancient artificers were acquainted with the fact.

After the extensive use of copper and bronze in ancient Egypt, other metals were gradually employed. Silver, as distinct from electrum, seems to have been little used, except for ornamental purposes.† The diadem of one of the kings named Antef (B. C. about 2700), and that of the Princess Noubhotep (B. C. 2400), were made of silver and gold. Silver also occurs among the beautiful jewelry of the princesses buried at Dahshur, and that of Queen Ahhotpu. But when the intercourse between Egypt and the neighboring nations of Asia was better established, silver became much more common; thus we find it frequently mentioned in the Great Harris papyrus (B. C. 1200), in which the King Rameses III. describes his magnificent presents to the temples and priesthood of Egypt. The metal lead also occurs frequently in the same lists, and was used, as elsewhere, for mixing with copper and tin in the formation of the easily fusible bronze used for statuary.

Tin has a more interesting history. We have found it used in combination with copper as far back as perhaps B. C. 3400, and enormous quantities of it must have been afterward employed. It is still a question whether in the first instance some stanniferous copper ore was used, or whether the Egyptians found that the addition of a certain black mineral was advantageous for hardening their copper, or whether from early days they reduced the metal from its ore and added it to the copper in the furnace. That, at any rate, they were afterward acquainted with the metal itself, is clear from the discovery by Flinders Petrie of a small ring at Gurob (B. C. 1450), which, on examination, I found to be of tin, imperfectly reduced from its ore. Berthelot has also analyzed what was essentially a tin ring, though alloyed with copper, dating about a century later; and Prof. Church describes a scarab of the same metal, which was found on the breast of a mummy of about the seventh century B. C. This metal also appears more than once among the rich gifts catalogued on the papyrus of Rameses III., if "tehi" is to be so translated.

Although kohl, the sulphide of antimony, was used for blackening the eyebrows from a very early period, I am not aware of any metallic antimony in Egypt of older date than some beads found by Prof. Petrie at Illahun in a tomb of about 800 B. C. They proved to be fairly pure metal. It is curious that the art of preparing this metal was afterward lost, and only rediscovered in the fifteenth century of our era.

The period of the first use of iron in Egypt is at present a matter of great controversy. Some contend for its use even in the mythological period, while others would bring it as late as 800 or 600 B. C. There exist the oxidized remains of some wedges of iron intended to keep erect the obelisks of Rameses II. at Tanis, which is near the border of Palestine; but there is no positive proof that they were placed there during his reign. I have little doubt, however, that the Black Baa, mentioned several times in the Harris papyrus, B. C. 1200, is the same as the *μελας σιδηρος* of Hesiod; i. e. iron. In the long account which King Piankhi gives of his invasion of Egypt from the Upper Nile, he mentions iron more than once among the presents made to him by the minor chieftains of the time in token of their submission, indicating that at this period, B. C. 700, it was still not very common.

ASSYRIA.

In the country lying between or near the Euphrates and the Tigris we have some antiquities dating, perhaps, as far back as any in Egypt. We have also a great amount of Accadian and Assyrian historical and other literature on tablets and cylinders of clay, and on the walls of the great palaces and temples. As in the case of Egypt, the discoveries of the remotest age are those which have been most recently published. Dr. Peters has just given us the records of the explorations of the American Oriental Society at Nippur, and de-

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* A Friday evening discourse delivered at the Royal Institution on February 11, by Dr. J. H. Gladstone, F.R.S.

* Since the lecture was delivered the Egypt Exploration Fund has issued a memoir under the title of "Deshasheh," from which it appears that in the very ancient tombs at that place there were found a few gold beads and copper objects and a picture of an artificer weighing a copper bowl.

* For tabulated results of experiments bearing on these points, see "The Testing of Materials of Construction," by Prof. Cawthorne Unwin; and the second Report to the Alloys Research Committee of the Institution of Mechanical Engineers, by Prof. Roberts-Austen, with the discussion thereon.—Proc. Inst. Mech. En., April, 1893.

† In the translation of "The Book of the Dead," by Dr. Wallis Budge, vol. iii., published since the lecture, it appears that in one of the oldest chapters, said to have been found by Herutataf, about B. C. 3900, there is a formulary to be said over a scarab of greenstone encircled with a band of refined copper and having a ring of silver.

scribes the successive layers of the great temple of Bel. These appear to indicate the absence of metal in very remote periods. The oldest specimens are those recently found by M. de Sarzec at Tello (Lagash) in Southern Chaldæa. They consist of some votive statuettes, and a colossal spear, an adz and curved hatchet, all of copper without tin, according to M. Berthelot's analysis. A small vase of antimony and a large one of silver have also been found. The period of these is supposed to be some considerable time anterior to B. C. 2500. At Tel el Sifr, in the same neighborhood, Mr. Loftus discovered a large copper factory, in which were caldrons, vases, hammers, hatchets, links of chain, ingots and a great weight of copper dross, together with a piece of lead. The date of these is believed to be about B. C. 1500. At Nippur the American explorers found at a higher level, in the temple of Bel, what they term a jeweler's shop, which consisted of a box full of jewelry, mainly precious stones, but also containing some gold and copper nails; these apparently date from about B. C. 1300. In Babylonian graves and other places of about the same period there have been found objects made of copper and iron and silver wire; but the use of metals seems much more restricted in these great alluvial plains than in contemporary Egypt. Iron, however, was perhaps an exception. According to Messrs. Perrot and Chipiez, excavations at Warka seem to prove that the Chaldæans made use of iron sooner than the Egyptians; in any case, it was manufactured and employed in far greater quantities in Mesopotamia than in the Nile Valley; in fact, at Khorsabad M. Place found hooks and grappling irons, fastened by heavy rings to chain cables, picks, mattocks, hammers, plowshares, etc., in all about 157 tons weight. Mr. Layard also found at Nimroud a large quantity of scale armor of iron in a very decomposed state, but exactly resembling what is represented in the sculptures of warriors. Of this he collected two or three basketfuls.

Coming down to the period of the great Babylonian empire, we find very large treasures of the precious metals changing hands during their sanguinary wars. Thus, on the black obelisk of Shalmaneser II. in the British Museum, we have depicted the embassies from different nations bringing their tribute to the feet of the king; the second of these has an inscription reading: "The tribute of Jehu, son of Omri; silver, gold, bowls of gold, vessels of gold, goblets of gold, pitchers of gold, lead, scepters for the king's hand, and staves; I received." The gates of his palace at Balawat, now at the British Museum, were of stout timber strengthened with bands of bronze, and the trustees kindly gave me a small piece of the metal for analysis; it yielded about 11 per cent. of tin. The grandson of this king, Rimmon Narari III., probably B. C. 797, took Damascus, and the spoil, according to the inscriptions, comprised 2,300 talents of silver, 20 of gold, 3,000 of copper, 5,000 of iron, together with large quantities of ivory, etc.

Lenormant gives two verses of a magical hymn to the god Fire, which exist both in Accadian and Assyrian; they run: "Copper, tin, their mixer thou art; gold, silver, their purifier thou art."

PALESTINE.

Between the great territories of Egypt and Assyria lies a narrow strip of country, small in extent, but very important in the history of civilization, commerce and religion. During the period of which we are speaking it was occupied by a succession of different nations. It formed part of the possession of the great Hittite people. We cannot read their inscriptions, and we know little of their history. We have, however, bronze and silver seals that are supposed to belong to them and curious bronze figures. They seem to have had abundance of silver, probably from the mines of Bulgardagh in Lycaonia. We read of Abraham purchasing a piece of land from Ephron the Hittite for which he weighed out "four hundred shekels of silver current money with the merchant." He was, in fact, rich in silver and gold, and among the presents given to Rebekah were jewels of silver and jewels of gold.

The first notice of metals in Palestine to which we can give an approximate date is in connection with the invasion of that land, and other countries further to the eastward, by the great Egyptian King Thothmes III. He led his army through the plain of Esdraelon, and gained a victory at Megiddo, and among the spoil were chariots inlaid with gold, chariots and dishes of silver, copper, lead and what was apparently iron ore. This took place about B. C. 1600. The original of the long treaty of peace and amity between Katesir, King of the Hittites, and Rameses II. is said to have been engraved on tablets of silver.

When the children of Israel left Egypt they were, of course, acquainted with the metals used in that country. They borrowed the jewels of silver and gold of their oppressors: and of these the golden calf was afterward made. We read, too, of the "brazen serpent,"* and of elaborate directions for the use of silver, gold and brass in the construction of the Tabernacle. Lead is mentioned once, but iron seems to have been unknown to them, the word never occurring in the Book of Exodus; and though it is occasionally mentioned in the later Books of Numbers, Deuteronomy and Joshua, it is always with reference, not to the Israelites, but to the nations they encountered. Thus we read of the Midianites having gold, silver, copper, iron, tin and lead, which were to be purified by passing through the fire; of the King of Bashan, a remnant of the Rephaim, who had the rare luxury of an iron bedstead, which was kept afterward as a curiosity at Rabbah; and of the spoil of the Amorite city of Jericho, comprising gold, silver, copper and iron. Later on the Canaanites were formidable with their "nine hundred chariots of iron;" and later still the Philistines, whose champion, Goliath of Gath, was clad in armor of bronze, and bore a spear with a heavy head of iron. Among the materials collected by David in rich abundance for the building of the Temple were gold, silver, bronze and iron; but the best artificers in metals were furnished by Hiram of Tyre, at the request of Solomon. During the reign of the latter there was an immense accumulation of these precious metals in Jerusalem. The comparative value of the different materials is indicated by the words of the prophet in describing the Zion of the future: "For brass I will bring gold, and for iron I will bring silver, and for wood brass, and for stones iron" (Isaiah lx. 17). Another prophet (Jeremiah vi. 29, 30) uses the simile of the refining of silver by the process of cupellation.

The great mound of Tel el Hesy affords a very perfect example of the débris of town upon town during many centuries; and of the light that these mounds throw upon the progress of civilization. When Joshua, after the decisive victory of Bethoron, led his troops to the plain in the southwest corner of Palestine, he besieged and took Lachish, a city of the Amorites. It then became an important stronghold of the Israelites; its vicissitudes are frequently mentioned at various dates of the sacred history, as well as on the Tel el Amarna tablets. The mound has lately been explored by Messrs. Petrie and Bliss: and in the remains of the Amorite city (perhaps B. C. 1500) there are large rough weapons of war, made of copper without admixture of tin; above this, dating perhaps from 1250 to 800, appear bronze tools, with an occasional piece of silver or lead, but the bronze gradually becomes scarcer, its place being taken by iron, till at the top of the mound there is little else than that metal. The Palestine Exploration Fund has kindly lent me specimens of these finds for exhibition. About B. C. 700, Lachish was the headquarters of Sennacherib, during his invasion of Palestine. From it he sent his messengers to Hezekiah, and at the same town he received the peace offering of the Jewish king, 300 talents of silver and 30 talents of gold, to raise which he had to despoil his palace and the Temple. In Sennacherib's own version of the transaction, the silver is given as 800 talents, and the gold 30. Lachish was finally deserted about 400 B. C.

GREECE.

We know little of the very early history of Greece, for the most ancient monuments bear no inscriptions, and literature did not commence till the time of the Homeric poems. In these, and in Hesiod, there are many graphic descriptions of the habits and arts of the heroic period, including the use of metals; and many of the towns described in them have recently been explored with great success, and have yielded up the very materials about which they sang.

Probably the earliest find has been in the volcanic island of Santorin, where, under beds of pozzolana, which are supposed to date about 2000 B. C., have been found two little rings of beaten gold and a saw of pure copper. In the Ashmolean Museum there are a very ancient silver ball and beads of the same metal rolled from the flat; also a spear head of copper. These were obtained from Amorgos. In Antiparos there have also been found very ancient objects of silver mixed with copper.

Passing to the mainland, the towns of the Peloponnesus and the mound of Hissarlik, the supposed Troy, have been explored by Dr. Schliemann, Dr. Tsountas, and Dr. Dorpfeld; and they reveal what is termed the Mycenæan period, which figures so largely in the poems of Homer and Hesiod. In these the precious metals, gold and silver, are constantly mentioned, together with χαλκος, generally translated brass. Thus, in the description of Achilles' shield, we are introduced to Hephaistos at his great forge on Etna, heating the bars of silver, or brass, or tin, or gold, and then hammering them on the anvil, so forming the designs which represent so beautifully the various scenes of peace and war. After having fashioned the shield he is represented as forging for the warrior a cuirass of copper, greaves of tin and a helmet with a golden crest.

Homer frequently mentions iron, but generally gives it the epithet "worked with toil," and treats it as a rare and costly metal. Thus a huge iron discus was given as a valuable prize to the hero who could throw it the farthest in the athletic games at the funeral of Patroclus.

Mr. W. E. Gladstone, who has long turned the great powers of his mind from time to time to Homeric studies, wrote me last summer: "The poems of Homer showed me, I think, forty years ago that they represented in the main a copper age." The reasons he assigns in his letter, as well as in his published works, are fairly conclusive, and the recent explorations, and the analyses of Dr. Percy, Prof. Roberts-Austen and others, have shown that in the early period of the Mycenæan age copper without tin was employed for numberless purposes; but as time advanced, bronze came into use. At Hissarlik, in the lowest and second city have been found a gilded knife blade, needles and pins of practically pure copper; while in the third and sixth cities occur battle axes of copper containing 3 to 8 per cent. of tin. In the very old town of Tiryns, the palace apparently had its walls covered with sheets of copper. Much lead was also found there. At Mycenai, the Achaian capital, the metals in use were gold, silver, copper, bronze and lead, copper jugs and caldrons are common, and great leaden jars for storing grain; also elegant bronze tools and cutlery; mirrors, razors and swords. In the tombs the bodies are laden with jewels, largely ornaments of gold, with a much smaller amount of silver.

Some of these objects illustrate the poems of the time; thus, in the Odyssey we find Nestor making a vow to Athenæ: "So the heifer came from the field; . . . . the smith came holding in his hands his tools, the means of his craft, anvil and hammer, and well made pincers, wherewith he wrought the gold. Athenæ, too, came to receive the sacrifice. And the old knight Nestor gave gold, and the other fashioned it skillfully, and gilded therewith the horns of the heifer, that the goddess might be glad at the sight of her fair offering." Now, at Mycenai there was found the model of an ox head in silver, with its horns gilded, and between them a rosette of gold, not directly attached to the silver, but to a thin copper plate. In Vaphio, a town near Sparta, of a somewhat later period, tombs were found containing many beautiful objects in silver, gold and bronze. Especially noteworthy are two golden cups embossed with figures of bulls and men; in the one case it is a spirited hunt in the woods, in the other a peaceful scene on the meadows. Iron, in Mycenai, appears only as a precious metal of which finger rings are formed.

In the remains of a Greek colony in Cyprus, belonging to the end of the Mycenæan period, which is now being explored by the British Museum, iron plays a much more important part. At Athens also large iron swords, which belonged to the ninth or tenth century B. C., have been found in an old cemetery.

After this came the intellectual period of Grecian history. Aristotle must be mentioned in any account of the science of the day; and he it is who gives us the first description of the metal mercury, and also how to produce the alloy which we call brass, by heating together copper and calamine, the carbonate of zinc. Metallic zinc, however, was not known for many centuries afterward.

CONCLUSION.

In tracing back the history of these great nations we have found evidence of a time when metals were little, if at all, employed; the potter's art was well known, and early man became wonderfully proficient in working hard stone, and especially flint. The earliest indications we have of metals are of gold and copper, both being scarce, and no doubt costly. Gold was probably the earliest to attract the attention of mankind, because it occurs native, of bright yellow color, and is easily worked. Copper, however, dates to a similar period, so far as the remains which have come down to us are concerned. Probably the deep blue carbonate, such as occurs in Armenia, was first worked. When silver was first used is not very evident, but it is certain that it was far more common in the northern portion of the area we have been considering than in the southern. The metallurgy of copper was doubtless a matter of much study and experiment, so as to produce the hardest metal. This seems to have led to the discovery of tin, but at what precise period we know not; nor do we know whether it was brought from Etruria or found in some nearer region. Mines of tin were certainly worked at Cento Camarelle, as Egyptian scarabs have been found in the old workings,* and near Campiglia and in Elba, as well as in the Iberian peninsula. This search for the metals, and the necessity of carrying the ore or rough metal to the places where it was wrought, or of the finished material to distant customers, must have greatly promoted commerce. This took place both by land and sea, in caravans and ships. In this way tools and other objects were disseminated through the more distant parts of Europe and Asia: the similarity of type over large areas shows a common origin, and hence we can even roughly form an opinion as to whether they were introduced in earlier or later times. Thus, in Switzerland and Scandinavia we meet with copper implements as well as bronze, and ancient as well as modern forms; while in Britain we find no evidence of copper tools, though bronze objects are abundant.

The Phenicians, arriving on the eastern shores of the Mediterranean from the direction of the Persian Gulf, formed an important nation for about 1,000 years, from B. C. 1400 to B. C. 400. They were great artificers, but not having much originality, they adopted the patterns and designs of Egypt or Assyria. They were also pre-eminently traders, and founded cities and emporia of commerce, so that their metal work was spread over all the Mediterranean. It is to be found in Cyprus, mixed with the workmanship of the Grecian Mycenæan age. Their ornamental jewelry was eagerly sought in Etruria, Greece and Calabria; for the beauty of it I may refer you to the Etruscan cup of gold in the South Kensington Museum and the wonderful work in gold in one of the Greek rooms in the British Museum.

Commerce implies a large extension of a medium of exchange. The whole question of money is far too wide a subject for us to deal with now. Suffice it to say that Herodotus attributes to the Lydians the introduction of the use of coins. The earliest were of electrum, issued in the form of oval bullets, officially stamped on one side. They date back, perhaps, to B. C. 700; but according to other authorities, silver money was coined at Ægina more than a century before that time.

The great period which has been under our consideration terminated in each country with an age of disorder and deterioration. The rise of the Roman empire introduced a new era; it was in one sense an iron age—ferrum being synonymous with the sword. We now live in another kind of iron age, but in better and brighter times than those of Hesiod, and we may hope that our great engineering works, our iron roads and iron steamships may lead not to the enslaving but the brotherhood of nations.

* The word "brass" at the time of the translation of our Bible was used indiscriminately for copper or any of its alloys. In the Old Testament it never refers to the alloy of zinc to which the term is now confined.

* See "Early Man in Britain," by Prof. W. Boyd Dawkins.

According to a report of the British Chamber of Commerce in Egypt, plowing, thrashing and general farming implements are still not much in vogue, except on very large estates and government lands. The land, being flat, is most suitable for their use, and, if the Egyptian army is to be kept up to a greater strength than at present, hand labor will become scarcer and this class of machinery will replace it. The cotton ginning industry is very extensive all over the country. Some 3,000 to 3,500 gins are at work every year. This plant may be said to be almost all of British make. A very important evil, however, presents itself to the disadvantage of the English manufacturer. By constant working at a speed of 900 revolutions, the gins are subject to get out of repair, to breakage, etc., and the parts required to be replaced are counterfeited in Europe, and even in Egypt. The machinery used for corn milling, consisting of portable and fixed engines, is almost exclusively of British make. Pumping plant for irrigation purposes is imported mostly from Great Britain, although a foreign make of engines and boilers is gradually gaining a footing in Egypt. The demand is increasing since the government have made some important concessions for irrigation works in Upper Egypt.

The Illinois Steel Company has nearly completed its order from Japan for 50,000 tons of steel rails, secured over three months ago. Since January 1 over 100 solid train loads of rails have been shipped from their mills. These have been chiefly destined for export. They have gone to nearly all the Eastern, Southern and Western coast ports to be loaded on ocean steamers, according as the most reasonable rates of freight could be secured.

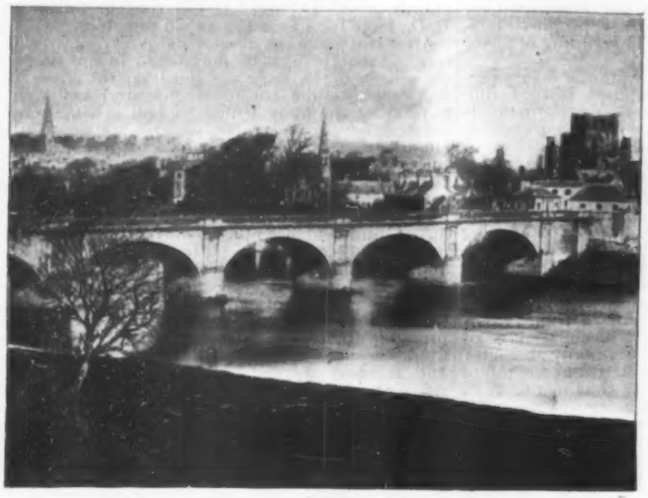


FIG. 13.—KELSO BRIDGE, KELSO, SCOTLAND.

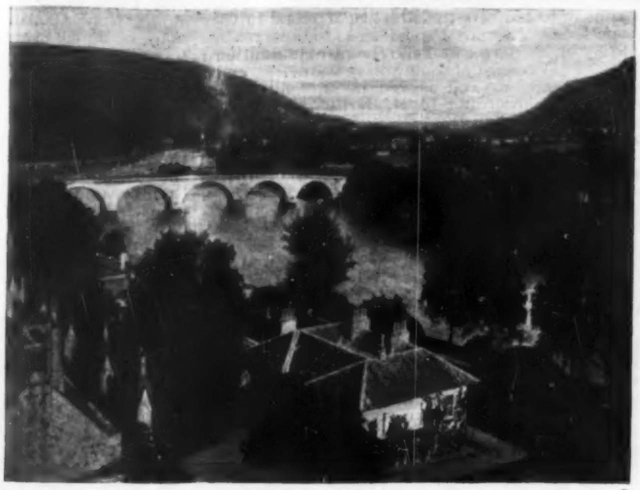


FIG. 14.—DUNKELD BRIDGE, DUNKELD, SCOTLAND.

FIG. 15.—WATERLOO BRIDGE OVER THAMES, LONDON.

FIG. 16.—LONDON BRIDGE OVER THAMES.

FIG. 17.—BROMIELAW BRIDGE, GLASGOW, SCOTLAND.

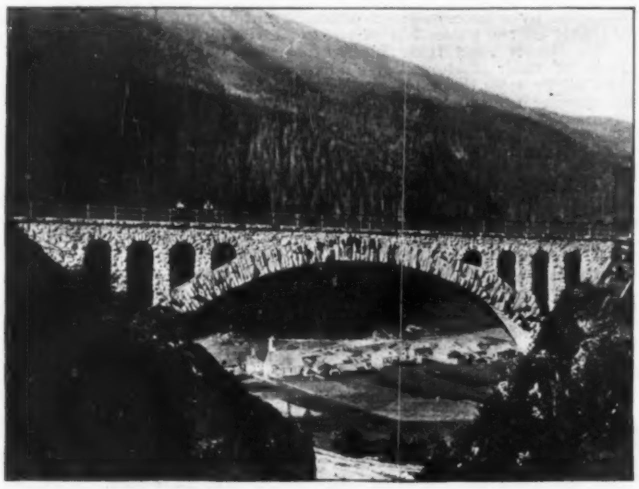


FIG. 18.—WALDI-TOBEL BRIDGE NEAR BLUDENZ, AUSTRIA (RAILWAY).

FIG. 19.—ELYRIA, OHIO.

FIG. 20.—MAIN STREET, WHEELING, W. VA.

[Continued from SUPPLEMENT, No. 1170, page 18736.]

HISTORY OF THE STONE ARCH.*

By Prof. MALVERD A. HOWE, Member of Engineers' Club of St. Louis.

IN 1553-1570 the Tempoala aqueduct, seven miles south of Huauchinango, Mexico, was constructed under the direction of a Franciscan friar. It contains sixty-eight semicircular arches, the largest having a span of 58 feet. Its maximum height is 124 feet. It is built on thirty-five pointed arches, the largest arch having a span of 100 feet and a rise of 88 feet. The height of the intrados of the maximum arch is 197 feet, while the maximum height of the bridge is 230 feet.

It is claimed that this is the highest masonry arch bridge, having but one tier of arches, in the world.

Pont-de-la-Concorde (built 1787), at Paris, France, has five segmental arches, the center span being 102·3 feet with a rise of 9·8 feet.

The Kelso bridge over the Tweed River, Kelso, Scot- seventeen elliptical arches, having spans varying from 65·86 feet to 86·92 feet. The maximum span has a rise of 28·9 feet.

The new Waterloo bridge, London, was opened in 1817 (Fig. 15). There are nine elliptical arches, with a span of 120 feet and a rise of 34·6 feet.

The new London bridge was built between 1821 and 1830 (Fig. 16). The five elliptical arches have spans varying from 130 feet to 152 feet. The rise of the maximum span is 29·6 feet above high water.

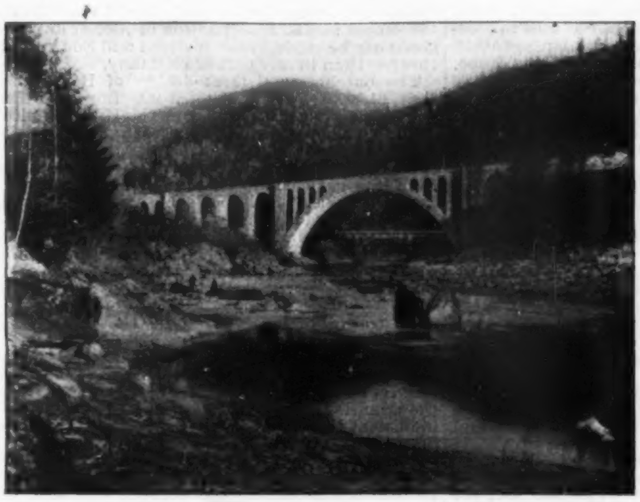


FIG. 21.—JAREMZE BRIDGE OVER PRUTH, AUSTRIA (RAILWAY).

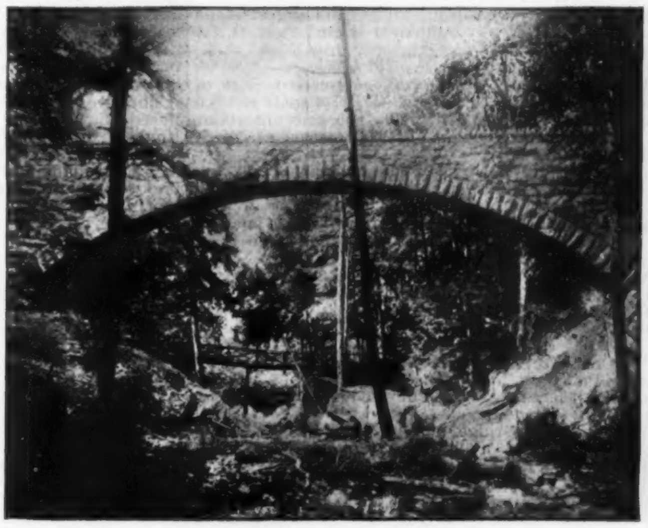


FIG. 22.—CRESHEIM BRIDGE, PHILADELPHIA, PA.

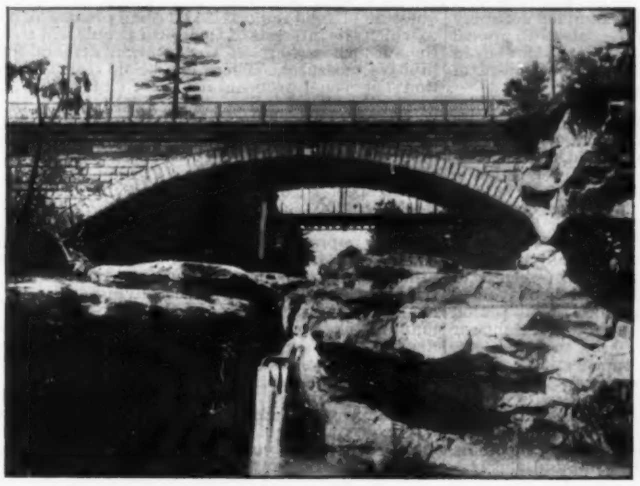


FIG. 23.—LODI STREET, ELYRIA, OHIO.

FIG. 24.—ECHO BRIDGE, BOSTON, MASS.

FIG. 25.—WISSAHICKON BRIDGE, PHILADELPHIA, PA.

FIG. 26.—BABYLONIAN ARCH OF BRICK AT NIPPUR.

two tangents 177 degrees apart. The waterway is only 8½ inches by 12 inches.

During the eighteenth century many fine bridges were built. Of these only a few can be mentioned. Near Lisbon, Spain, the Alcantara aqueduct was commenced in 1731 and completed about 1774. It contains land (Fig. 13), was built 1799-1803. It has five elliptical arches with a maximum span of 73 feet and a rise of 21 feet.

In 1809 the Dunkeld bridge over the Tay River, at Dunkeld, Scotland, was completed (Fig. 14). There are seven arches, the center span being 90 feet with a rise of 30 feet.

Between 1813 and 1822 a fine bridge over the Garonne River, at Bordeaux, France, was built. There are

The Bromielaw bridge, in Glasgow, Scotland (Fig. 17), has seven segmental arches, the largest having a span of 58·5 feet with a rise of 10·8 feet. It was constructed in 1833-36.

In 1841-47 the highest stone bridge in the world was constructed on the canal leading to Marseilles, France, where it crosses the Arc Valley. The bridge has three tiers of arches. The lowest tier has twelve arches of 49·2 feet span; the middle tier fifteen arches of 52·5

* Read before the club, December 1, 1897, and published in the Journal of the Association of Engineering Societies, to which we are indebted for the engravings and article.

feet, and the upper tier fifty-three arches of 16·4 feet span.

The bridge is 48 feet wide on top, 1,289 feet long and 271 feet high. The width of the canal on the bottom is about 22 feet.

Up to 1847 nothing of any magnitude, in the way of stone bridges, had been erected in the United States. During this year the Starrucca viaduct, carrying two tracks of the New York, Lake Erie and Western Railway, over Starrucca Creek, near Lanesborough, Pa., was constructed. There are seven segmental arches of 51 feet span, and the maximum height of the rails above water is 110 feet.

In 1852–59 the Cabin John bridge, the largest stone arch in the world, was built near Washington, D. C., to carry an aqueduct and highway over Rock Creek. Its span is 220 feet, with a rise of 57·3 feet.

The Waldi-tobel* bridge, in the western part of Austria, was built in 1884 (Fig. 18). Its span is 134·5 feet, with a rise of 42·16 feet, while the rails are about 160 feet above the bottom of the gorge which it crosses.

In 1884 a highway bridge, with a span of 150 feet and a rise of 27 feet, was built at Elyria, Ohio (Fig. 19).

In 1892, at Wheeling, W. Va., an arch with a span of 159 feet and a rise of 28·4 feet was constructed (Fig. 20).

In this year (1892) the Jaremze* bridge, the largest arch bridge in the world for railway purposes, was built in the eastern part of Austria over the river Pruth (Fig. 21). The span is 213 feet and the rise 59 feet.

The Cresheim bridge, in Fairmount Park, Philadelphia, Pa., built in 1892, has a span of 116 feet, with a rise of 21·1 feet (Fig. 22). This bridge carries a sewer over a small stream.

The Lodi Street bridge, at Elyria, O., has a span of 112 feet and a rise of 19·5 feet. It was built in 1894 (Fig. 23).

Probably the most pleasing stone bridge, from an architectural point of view, is the Echo bridge, at Newton Upper Falls, Mass. (Fig. 24). It has a span of 129 feet and a rise of 42 feet 4 inches. It carries an aqueduct and highway and was built in 1876.

During the present year a very artistic highway bridge has been built in Fairmount Park, Philadelphia, Pa. (Fig. 25). The span is 105 feet, with a rise of 11·0 feet.†

The examples of stone arch bridges given above are, of course, but a very small percentage of those which have been constructed. With but a few exceptions, only those structures have been mentioned concerning which the data are believed to be authentic and of which photographs could be obtained.

Data concerning even the more modern structures are very hard to obtain, and in many cases it is practically impossible to purchase photographs.

The following conclusions may be drawn from the above data:

The Romans first used the arch in the construction of bridges in the second century B. C.

Until about the thirteenth century the arch in bridges was of the circular form, and almost without exception it was semicircular.

The pointed arch was first employed in bridges about the thirteenth century.

In the fourteenth century segmental and elliptical arches were introduced.

At the present time the segmental arch is almost universally employed for long spans.

AMERICAN COMPETITION IN EUROPE.

SOME very interesting information on the subject of American competition in Europe is given in a report, dated December 31 last, by Mr. F. H. Mason, Consul General of the United States at Frankfort, on American competition in Europe.

The consul, in his report, states that the year 1897 will be remembered as an epoch in the industrial and commercial relations between the leading European countries and the United States. The remarkable fact of the year has been the enforced recognition of the truth that in several important lines of manufacture—notably that of iron and steel—the scepter of economical production combined with payment of the highest wages to labor has passed from the Old World to the New.

For years European economists have struggled against the conclusions which practical men are now forced to accept. It has been argued that, through what they regarded as a false fiscal policy, and the exaggerated wages accorded to labor, high cost of living and lack of general technical education, American manufactures, in which labor performed an important percentage of cost, could never seriously compete in the world's markets with the low wages, frugal living and twelve hour toil of the Old World, where, in many places, communities have been trained for generations in specialized forms of industry.

But it has been demonstrated that, under intelligent, progressive management, highly paid labor, especially when employed to use complicated machinery, is, after all, the cheapest, and that in the race for supremacy the people of the Old World have been, in many cases, left behind by those who, more than any other, have reduced economy of labor to an exact science.

An expert, who has traveled through the Atlantic States to find the secret of superior quality and cheapness of American factory-made shoes, brings back the surprising statement that in a certain Massachusetts shoe factory which he visited the average wage earned by all classes of operatives was £3 per week, and the net labor cost per pair of shoes produced 1s. 8d.; whereas, in German shoe factories, where the average earnings of operatives are only 16s. per week, the labor cost for shoes of similar grade is 2s. 5d. per pair. Facts like these have brought about during the past year a noticeable change in the attitude of technical journals and the more intelligent European manufacturers toward the growing danger from beyond the sea.

Hitherto, they have found it comparatively easy to persuade themselves that, but for the American tariff, which could be only a temporary measure, the United States might be held permanently to its function of growing food and raw materials for European operatives and manufacturers, who would supply the world with manufactured products. But it is now seen that it is something besides tariff that has made the cost of producing Bessemer pig iron 10s. to 15s. per ton less in the United States than in Great Britain, has enabled the steel makers of Pennsylvania to underbid those of England for the rails and other supplies of the London Underground Railway, and to place an order for 8,000 tons of steel rails with the British East Indian government. Neither has fiscal legislation enabled the machinist of Philadelphia, Pittsburg and Chicago to sell locomotives, mining and electrical machinery, street railway outfits, bridges and architectural iron in competition with British, German and Belgian agents in South America, Australia and the Cape of Good Hope.

Three years ago, German manufacturers honestly believed that, but for the import duty, they and their English rivals could monopolize the American market for bicycles and sewing machines. Since then the American-made bicycle has invaded successfully every important European market, and not only in quality, but in price, has made the competition in Germany so keen that the local makers now demand the imposition of a special high duty on American wheels as essential to their future existence. The steel bridge builders of Belgium and Great Britain have been surprised to find themselves underbid for the construction of an important bridge in Holland by a company in Philadelphia, and the leading makers of electrical machinery in the United States have set a standard of cheapness, prompt delivery, efficiency and economy of service, especially in electrical railway plants, with which their European rivals find it difficult to compete.

It is but natural that, these facts once recognized, the utmost use should be made of them in these older countries as arguments in favor of concessions and privileges which have hitherto been generally withheld. At Berlin a council of specialists has been recently in session to consider international tariff relations, with special reference to Great Britain and the United States. German economists point to the 18,000,000 tons of freight which pass annually through the single lock at the Sault Ste. Marie Canal as an argument in favor of the further improvement and extension of German waterways, and to the unexampled economy and efficiency of American railway freights as an appeal against the inert, exorbitant rates of state railroads in Germany. Director Schrodter, at the convention of iron and steel producers at Cologne, said:

"The German iron and steel industry may claim that in respect to technical capacity, it is not behind that of the great American plants, and, as we must not resort to wages reduction, except in the last extremity, the only means of relief is in lower freights. Without substantial help by this means the German iron and steel industry will not much longer be able to maintain its export trade as it at present exists, much less to increase it."

Expert officials have been sent over to study the construction, equipment and management of American railroads; and the result, thus far, has been the 60 foot long vestibule passenger car, mounted on pinion trucks; but the old four-wheeled ten ton freight car still maintains its placid sway.

It is not improbable that these appeals will have, in the near future, a more or less important effect. Already the freight rates for shipbuilding materials on the state railways between Westphalia and the shipyards of Stettin, Hamburg and other coast cities have been greatly reduced, and important improvements in the water route from Berlin to Stettin, and the projected waterway from Berlin to Rostock, via the Mecklenburg lakes, are movements in the same direction.

But by far the most significant sign of the times is the rapidly increasing popularity and use in Germany of American machinery and tools. Here, as also to a less degree in England, American machine tools have become the mode among the more progressive class of machinists and manufacturers. The fashion extends at present more especially to shoemaking and tanning machinery, automatic lathes, planers and milling machines, and to the important line of special machinery used in bicycle manufacture. Not only by reason of the superiority of their machines, but on account of the energetic, intelligent way in which several American firms have gone about the work of introducing them into Germany, they are entitled to special mention in this connection as examples of the advantage of undertaking a new task in the right way.

It seems impossible to repeat too often, or emphasize too strongly, the futility of trying to reach the German market with circulars and catalogues printed in English, with weights and values in pounds and dollars, or the importance of showing and explaining goods to the dealers and consumers in foreign lands who may become purchasers. Neither is it any longer sufficient for machinery and other merchandise to be exhibited only in London or Paris. In order to reach the German trade they must be shown, and, in case of a machine, set up and put to work at Berlin or some other large German city.

In respect to machine tools and some other classes of machinery, there is, of course, as a reverse side of the medal, the fact that all this eager adoption of American equipment and methods is only a means to the end of making German manufacturers more capable, and their home market eventually independent of manufactured imports from any country. When a German tanner equips his tannery with imported tanning machinery it is for the purpose, principally, of becoming able to compete more effectively with his foreign rivals, and make head against the important import of leather which now comes into Germany from the United States. When, likewise, a German shoe manufacturer fills his factory with machinery from Boston or Philadelphia, and goes or sends his foreman over to study American methods of using it, he is simply taking the most ready means of closing to American shoe manufacturers the field for their products in Germany, which they have been thus far so slow and indifferent to recognize and cultivate. The German bicycle maker who imports wood rims from Boston or Indiana, and provides his workshop with automatic machinery from Hartford or Waterbury, does so as a means to the end of shutting out the import of American-made bicycles.

All this is, however, the normal, progressive course of business. The fact is that, with the most modern and effective machinery, the most efficient labor, ample capital and an unequaled factory system, the United States, in the closing years of the century, fixes new standards in cheapness of production and passes definitely from the role of customer to that of competitor.

There is now in Germany a definite demand for American pig iron. Some has been actually imported from the Southern States, and its quality found satisfactory by the foundrymen in Silesia. But the report of this fact was coupled as a palliative with the published theory that the quality of Southern iron could not remain uniform, because a leading iron company there had dismissed its chemists, and would operate its furnaces in future by the methods of former times; but the simple fact is, that pig iron of almost any specified grade can be made in the Western and Southern States cheaper than in any part of Germany.

The butchers and meat dealers of Berlin complain that £1,597,000 worth of meat was imported into Germany in 1896, principally from the United States, and at prices with which they were unable to compete. They, therefore, petition the government to open the frontiers to the free importation of animals and meats from European countries, and to restrict, by all practicable means, the imports of meats from America, which are steadily increasing from year to year. The whole agricultural population is arrayed against the vast importations of wheat, corn and oats from the western hemisphere; and measures are under consideration to break the control which has been gained in the German market by American petroleum.

On the other hand, the industrial and commercial classes have taken the field against any and all artificial restrictions of the food supply. The Boersen Courier (Berlin) points out that with the scant European harvest of last summer, prices of food have risen until the situation of the laboring masses in the cities and industrial towns is becoming desperate, and that only a free and profuse importation of foreign cereals and meats from wherever they can be most cheaply obtained will avert famine conditions before another crop can be grown, and enable the working people to exist at their present scale of wages. While, therefore, the restriction against the importation of live cattle may continue, and the trade in American meats be surrounded with annoying and costly formalities, the question of food imports to Germany is one in respect to which the interests of their own people will constrain the authorities to resist the agrarian demand for prohibitive measures. There can be no serious combination between European nations to make the cost of food permanently dear. The lesson which they are learning from the United States is to cheapen the cost of production, while improving the quality, not only of manufactured goods, but, wherever possible, of agricultural products as well.

In respect to manufactured merchandise, the question is much more complicated. Important progress will doubtless be made by using highly perfected machinery, improving their factory system, increasing the efficiency of labor and resisting the high freights and other expenses that are paid as more or less direct contributions to the state. The rallying cry at the present moment in the beet sugar industry is that sugar manufacture must be cheapened and made free and independent of export bounties. This it is proposed to accomplish by, first, concentrating the manufacture of raw and refined sugars into large factories, where all processes can be performed on an immense scale, by the most improved methods and with greatest economy of labor; second, by securing from the government, instead of export bounties, a nominal rate of transport for beets and sugar over the state railways and canals. This, with such an increase of manufacturing capacity as will enable the entire beet crop to be worked up between the commencement of gathering and the coming of frost, would save all expense of storing the beets in earth barrows or cellars and reduce the active campaign from six months to three.

Another valuable suggestion which Germany, as well as other European countries, is receiving from the United States, is the importance of small things in practical mechanics and technology, the market value of an apparently simple device or improvement, which enables one of the consecutive operations in a process of manufacture to be performed better or more cheaply than has been done before. Until recently, it has been a matter of surprise that the United States government should be so ready to grant patents for simple mechanical improvements which present no claim of elaborate theoretical novelty. It is now seen that the ultimate sum of these small improvements—invented in many cases by the workmen who build or the operative who uses a machine—is machinery of the highest efficiency, although none of the successive improvements which it embodies would be intricate or theoretically original enough to be patented in Europe.

In conclusion, Consul Mason says: "From all that can be foreseen, it would appear that competition in Germany will sharpen and become more determined as processes are improved, and the whole economy of production brought more and more nearly upon equal terms. The contest will be one between natural resources, the inventive capacity to economize labor, reduce freights and save waste of material, and, above all, the ability to skillfully sell surplus products in foreign markets. In all these, except the last, Americans are acknowledged masters. When they learn and act unitedly upon the knowledge that foreign trade must be found, developed and maintained by the same means that have been so effectively employed at home—by the persistent personal efforts of competent salesmen, showing the goods in presence of the customer and offering them to him in the weights, values and measures, and upon terms of sale and payment that prevail in foreign markets—there need be no fear of the result."

General Manager Yager, of the Wagner Palace Car Company, has issued a circular designating specifically the various compartments of sleepers. The circular states that hereafter all rooms having three berths will be termed drawing rooms; rooms having two berths and rooms now known as compartments will be termed staterooms; cars heretofore termed drawing-room cars will be termed parlor cars, and rooms in these cars will be termed compartments.

* This bridge was designed by Mr. Ludwig Huss, chief engineer of the Austrian State Railways, to whom the author is indebted for the photograph.

† Through the courtesy of Mr. John C. Trautwine, Jr., the author obtained photographs of this bridge.

ELECTRICAL NOTES.

Mr. George Westinghouse, Jr., offers the entire electrical equipment as a gift to the proposed new Allegheny Observatory, comprising generators, motors, etc., of Westinghouse make.

The Governor of Massachusetts has signed a bill which substitutes electricity for hanging as the method to be followed by that State hereafter in putting to death condemned criminals. Executions will take place in the State prison at Charlestown. The law does not apply to persons condemned for acts committed prior to its passage.

It is reported that the government has leased the electric searchlight at Mount Lowe. It will be mounted at San Francisco and used at night over the bay in connection with the fortifications. It is said to be the largest searchlight in the world. It is 10 feet 6 inches in diameter and weighs about 6,000 pounds. The mirror used in the projector is 5 feet in diameter.

News of the latest application of electro-mechanical energy comes from Boston, Mass., where an electrically operated circular saw is being provided for amputating limbs in the Emergency Hospital. The saw will be mounted on a flexible shaft, and the bearings in which the saw arbor runs are attached to a handle, by which the surgeon is able to direct the saw at any angle. Not only does the saw cut much faster than a hand tool, but the heat produced by its rapid cutting is said to sear the flesh and blood vessels, so that the healing processes of nature are advanced.

According to the Berliner Politische Nachrichten, Herr Naus, chief of the Belgian commission which has just arrived in Teheran to undertake the reorganization of the Persian customs, took occasion when passing through Cologne and Berlin to promote a great Persian railway enterprise, for the execution of which a mixed German and Belgian company has been formed. The company aims at connecting the Caspian Sea and Teheran by a railway which could ultimately be extended to the Persian Gulf. Herr Naus conferred with the German railway engineers on the subject.

Lighting the pyramids of Egypt with electricity and the installation of a 25,000 horse power plant, to cost some $400,000, is a plan now under consideration by the British government, and the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., are reported as likely to receive the contract, says The Engineering News. As outlined, the plan includes the generation of electric power at the Assouan Falls on the Nile River and its transmission a distance of 100 miles through the cotton growing districts, where, it is believed, the cheap power will permit the building of cotton factories. It is planned to use the power to illuminate the interior corridors of the pyramids and also operate pumping machinery for irrigating large areas of desert along the Nile.

According to L'Elettricita, a Russian patent has been granted for the manufacture of permanent arc lamp carbons. These are composed of the purest carbon mixed with finely powdered silicon carbide, some adhesive material, such as molasses, being used. A mixture of 90 per cent. of carbon and 10 per cent. of silicon carbide is said to be a good composition, though the proportions can be varied indefinitely. The electrodes can also be made with a core of the carbide or the latter may be combined with any conducting material, such as carbon, to form the core. Since silicon carbide can only be produced by the action of a temperature approximately that of the arc, it contains no volatile ingredients and has the highest resistance to oxidation of all known substances. It develops a very intense light and seems to promise excellent results. As the carbide is not a conductor, it is not possible to use it as an arc lamp electrode except in combination with carbon.

Our Parisian contemporary L'Industrie Electrique hears that Messrs. Tosi and Medina are proposing to build an electric tramway between Rome and Genzano with a branch in the direction of Roca di Papa. The line will be of normal gage with Phenix rails on oak sleepers placed at distances of about 3 feet apart. The steepest gradient will not exceed 9 per cent. and the sharpest curve 92 feet radius. The length of the line will be about 26 miles, divided into three nearly equal sections forming a Y. The generating station is to be at Capanne di Marino, at the center of the Y, and will comprise five Dowson gas engines each of 120 horse power driving continuous current dynamos. One of these three sets constitutes a reserve. The station will also supply light to the streets and villas of Castelli Romani. The adoption of gas engines is primarily due to the lack of water. Overhead distribution at 1,200 volts is used with the rails as return. Motor cars are to be used with one or two trailers as required. The speed will vary from 9½ to 18½ miles an hour, and each motor car will carry two 35 horse power motors.

The patent taken out by Dr. Auer von Welsbach, for improvements in filaments for electric lamps, has now been published by the Austrian patent office, says Electricity. Dr. von Welsbach first claims the use of: (a) osmium; (b) osmium combined with other metals of the platinum group (e. g., platinum, iridium, rhodium and ruthenium); (c) a filament of osmium coated with thoria, and (d) a filament of another metal of the platinum group coated with thoria, or alloyed with osmium and coated with thoria. Next, several methods of producing the filaments (a) and (b) are claimed. A thin metal wire is used as a core, and covered with osmium or an osmium compound, and afterward the core is incandesced and volatilized. The coating is either precipitated on the wire by reducing in reducing gases a volatile osmium compound, such as the tetroxide, or thin layers of the osmium or osmium compound are laid on, with the help of a binding material, if necessary, or the coating is applied electrolytically. Another method is to lay the osmium or osmium compound, mixed if necessary with the binding material to the consistency of a thin paste, onto a vegetable or animal thread; and still another to make an emulsion of it with collodion, which is afterward denitrated. The third claim is for the production of the filaments (c) and (d) by applying successive thin layers of thoria until a sufficient thickness of this oxide has been formed.

MISCELLANEOUS NOTES.

The prevalent idea that slow eating is very favorable to digestion is largely fallacious, says The Journal of Mental and Nervous Diseases. "The important point is not that we eat slowly or fast, but that when we do eat we chew with energy. Of course, where the haste is due to some mental anxiety, this may injuriously inhibit the secretions. Slow eating begets a habit of simply mumbling the food without really masticating it, while the hurried eater is inclined to swallow his food before proper mastication. Hence, hurried eating is bad, but rapid mastication is advantageous. It concentrates our energies on the act in question, and hence more thoroughly accomplishes it. Moreover, energetic chewing stimulates the secretion of saliva in the most favorable manner. These various points are so commonly misunderstood, a least by the laity, that they demand our frequent attention."

The United States consul at Prague, in Bohemia, in a recent report to the State Department, suggests that there is a vast field for the products of American enterprise in Bohemia, especially for mowers, binders, seeders, thrashing machines, haystackers and other farm implements. The consul adds: "Bohemia, being the most productive state of the Austrian empire, will advance in internal improvements. So far but little has been done, and the field is open; especially is this the case with electric roads, elevators and electric lights." There are in the consul's district a number of electric street car lines projected, and United States contractors could successfully compete in this line; at least, our firms could furnish the necessary machinery. The horse car line now in Prague is to be turned into an electric line and to be extended. The city of Pilsen will also construct electric lines. In the opinion of the consul, some one thoroughly conversant with this line should visit the various places, so as to be able to give figures and offer bids.

Some time ago it was proposed to celebrate this year the 700th anniversary of the discovery of coal in Europe, which, it was claimed, was made near Liege, in Belgium, in 1198. Dr. F. Buttgenbach has now published a pamphlet to prove that the first discovery was made 85 years earlier, in 1113, in the basin of the River Worm, north of Aix-la-Chapelle. He brings forward, says The Engineering and Mining Journal, much evidence to prove that outcrops of coal were worked in that year and long after by the monks of Kerkrade, who first discovered its qualities as fuel and utilized the mineral, or "black earth," as it was called. The word "kuhl," an old German term meaning a pit, was the origin, according to this statement, of the German "kohl" and the English "coal." The generally accepted legend has been that coal was first used at Liege by a blacksmith named Hullos, from whose name comes the French "houille"—coal. He found that the "black earth" which outcropped near Liege could be used in the forge instead of charcoal. Coal, however, had been used at Sheffield, in England, some fifteen years earlier for the same purpose.

The Germans attach much importance to compulsory education from the earliest youth. The education of children is absolutely compulsory from the age of six to fourteen; only in exceptional cases, where the child is considered to be sufficiently advanced, and is required at home, is there a departure from this rule. All elementary schools are free of fees; in small villages there are eight different divisions, though the children may possibly be taught in one room by one and the same master, whereas in towns it is found sometimes necessary to subdivide the divisions, thereby forming sixteen different classes. There are no examinations. These schools, says a German consular report, are supported partly by the state and partly by the community, in most cases the state paying about half the cost. As to proportion, very much depends upon the taxpaying powers of the community; as a general rule, there is no special school tax. In religious education the children are separated according to confession. There are special seminaries where teachers of both sexes are qualified for higher grades of education. The community appoints the teachers, subject to the sanction of the state. Children between six and fourteen years of age can only receive education from duly qualified teachers. No one is allowed to teach at either private or public schools without having passed a specified examination. All higher schools levy fees, and private schools can only be established under sanction of the state.

From a report on the wounded in the naval battles between Japan and China, presented at the International Medical Congress, at Moscow, by S. Suzuki, M.R.C.S. Eng., L.R.C.P. Lond., fleet surgeon of the Imperial Japanese Navy, for the first time in the history of naval warfare an adequate idea of the physical effects upon the combatants of sea fighting under the modern conditions of the opposition of powerful armaments to massive armor is obtainable. Of the 298 men killed or injured in the battle of the Yalu, a greater number suffered from injuries to the head than any other part of the body. The injuries to the greater part of the body naturally caused the largest percentage of deaths, for the reason that a large number of them consisted of burns covering an area of more than one-third of the body. Only two out of fifty-seven cases of this class recovered. Wounds to the abdomen and lumbar region were very fatal, because, unlike the simple punctures of rifle bullets, these consisted for the most part of fearful lacerations of the body and contained viscera by fragments of shell. On comparing the number of wounds received in a land battle with those of a sea fight between opposing forces of equal numerical strength, it appears that the number of wounds is almost identical, but that while in naval battles wounds of the head, in land battles wounds of the extremities predominate. Fleet Surgeon Suzuki explains this by the fact that bullets and shells, the chief causes of injury in fighting on land, are more apt to hit the extremities, while in sea fights the flying splinters of steel and wood from shattered armor, planking and rigging are more apt to hit the heads of the combatants. As an example of the damage from flying splinters, it is related that the funnel of the "Fuso," having been perforated by a shell, the fragments of it were dispersed around and either killed or injured ten seamen.

MISCELLANEOUS FORMULÆ.

Platinum Toning Baths.—The tones obtained on gelatino and collodio chloride papers with platinum are much in favor at the present time. The tones tend from warm sepia to brownish black. The most satisfactory is:

Potassium chloroplatinite	2 g.
Dilute phosphoric acid	120 "
Distilled water to	1,000 c. c.

This bath may be made up in concentrated form, the total bulk being made up to 200 c. c. For black tones the procedure is somewhat more complicated, but so many amateurs want black tones on these papers that a set of baths that would give these ought to sell well.

No. 1.—A.

Sodium acetate	10 g.
Borax	8 "
Distilled water to	100 c. c.

No. 1.—B.

Gold chloride	1 g.
Distilled water to	10 c. c.

For use mix 10 c. c. of A and 0·2 c. c. of B and water to 100 c. c.

No. 2.

Acid phosph. dil	25 c. c.
Distilled water to	100 "
Potassium chloroplatinite	2 g.

For use mix 1 part with 9 parts of water.

No. 3.

Ammonium sulphocyanide	100 g.
Chloride of gold (neutral)	2 "
Distilled water to	1,000 c. c.

Directions.—Print rather deeply and wash the prints in two changes of water for fifteen minutes. Immerse the washed prints in the gold bath No. 1 till they assume a brown tone, and then rinse in water and transfer to the platinum bath No. 2, in which they should be left till they assume a violet tone. Wash for 10 minutes and transfer to a 10 per cent. solution of hypo. in which they should be left for ten minutes, then well washed in four or five changes of water for twenty minutes, and if the tone is satisfactory (and it will be brownish), they may be mounted. If black, blue black or gray tones are required, wash the prints for five minutes only after fixing, and transfer to No. 3 solution, and in this they may be left till the desired tone is attained.—Pharm. Jour.

Mountants.—The following is a satisfactory mountant for all kinds of prints:

White dextrin	75 g.
Alum (powdered)	4 "
White sugar	15 "
Distilled water	120 c. c.
Dissolve by heat, and when cool add	
Alcohol sol. thymol (10 per cent.)	6 "

LIQUID MOUNTANT.

Soft gelatin	40 g.
Distilled water	120 c. c.
Allow to soak for 24 hours and add	
Chloral hydrate	20 g.

Heat on a water bath till liquid or for about an hour and then neutralize with a few drops of solution of carbonate of soda.—Pharm. Jour.

Paper Paste, to Adhere to Metal.—

Pulverized gum tragacanth	1 oz.
Pulverized gum arabic	4 "
Cold water	20 fl. oz.
Glycerin	4 "
Thymol	30 grains.
Boiling water	12 fl. oz.

Mucic Gum, or Paste for Tissue Paper.—

(a) Pulverized gum arabic	2 oz.
White sugar	½ "
Boiling water	3 fl. oz.
(b) Common laundry starch	1½ oz.
Cold water	3 fl. oz.
Make into a batter and pour into boiling water	32 "

Mix (a) with (b) and keep in a wide-mouthed bottle.

Perfect Paper Paste, for Paper Only.—

(a) Powdered gum tragacanth	1 oz.
Boiling water	8 fl. oz.
(b) Pulverized gum arabic	1 oz.
Salicylic acid	½ "
Boiling water	2 fl. oz.
(c) Wheat flour	2 oz.
White dextrine	½ "
Cold water	2 fl. oz.
Make into a batter and pour into boiling water	12 "

Mix (a) with (b), then add (c); finally add ½ ounce glycerin, to which has been added 8 drops oil of lavender. This is a good preparation, but is rather complicated and too much work to make up.

Parchment Paste, for Heavy Paper.—

(a) Pulverized rice	2 oz.
Boiling water	12 fl. oz.
(b) Pulverized gum arabic	2 oz.
Boiling water	4 fl. oz.
(c) White sugar	1 oz.
Salicylic acid	16 grains.
Boiling water	1 fl. oz.

Boil (a) for about half an hour, let cool somewhat, strain, and then stir in (b) and (c). This paste is from an old English recipe and is a nice article; but, like the preceding, it is too much trouble taken for the result obtained.—Western Painter.

Hardening of Rubber.—An Austrian patent has been recently granted to Messrs. Hornung & Hansel for a method of preventing India rubber from becoming hard. The invention consists in adding to the rubber, before its vulcanization, a plastic mass composed of a vulcanized oil and a glue insoluble in water. The oil is added to the glue first and then the mixture is incorporated with the rubber.—Wiener Gewerbezeitung.

THE STRATEGIC VALUE OF CABLES.

The present regrettable state of affairs between Spain and the United States, which is a matter of the greatest interest to the whole civilized world, not only on account of the immediate conditions brought day by day before our notice, conditions to which no one can be indifferent, but also on account of the consequences which must inevitably follow when the struggle is concluded, and the time comes for readjusting the balance. This situation brings home to us in a practical way a lesson which we should not ignore, although it is not bought by our own natural experience. There are doubtless many points of importance in the war now going on to which the attention of the strategist, naval or military, may be directed with advantage; and there are new problems in politics being evolved which will sooner or later have to be dealt with, but we wish to confine our view to what may seem comparatively a detail of the present complications; yet one which is of the greatest moment, and on which at any time the fortune of war may turn. We have on several occasions laid before our readers our views as to the conditions to which submarine cables are subject in time of war, and have given instances of the invaluable part which these are sometimes called upon to play in such circumstances.

It may, perhaps, be within the recollection of some, that on the occasion of the meeting of the "Convention for the Protection of Submarine Telegraph Cables," which took place in Paris as far back as in April, 1884, a favorable opportunity for establishing the neutrality of cables in war time was unfortunately lost. The result of this convention, at which all the great powers of the world were represented, was a common agreement, which, however useful to restrain and penalize willful damage to cable property in time of peace, did worse than nothing for their protection in time of war.

By formulating and agreeing to Clause XV. of this convention a liberty of action was proffered to belligerents, of which some of them, at least, would have hesitated to avail themselves had not this clause been generally assented to. This portion of the convention reads as follows:

"Article XV.—It is understood that the stipulations of the present convention do not in any way restrict the freedom of action of the belligerents."

It has been said that, in case of war, cables would be cut when and where necessary, without regard to proprietorship and to after consequences; but whatever moral restraint may have existed before this convention was concluded, or whatever fear of arousing prejudice, if not of provoking actual armed intervention, may previously have existed, has been quite done away with by the carte blanche given in the convention. Let us examine the position as it actually stands at present. It is of the utmost importance to each of the combatants that they should have speedy and accurate news of events as they occur, relating to the position and movements of war vessels, the transport and landing of troops, and reports as to the success or failure of the various operations of war. Here Spain is heavily handicapped, as the cable routes by which information may reach the United States are none of them under Spanish control, whereas the cables which united Florida with Cuba, the property of an American company, are under the control of the United States authorities at Key West. From this point communication with the fleet off Havana, some 90 miles away, can be easily and quickly effected; thus giving the United States a great advantage. The other cable route to the south of Cuba, via Bermuda and Jamaica, is, we believe, still open, and the line from New York through Hayti to Santiago de Cuba, which belongs to a French company, is still working; although it is doubtful if the Spaniards are likely to make use of a cable which lands at New York.

However, we gather from a recent report of proceedings in the Cortes that Spain has taken "the necessary steps to maintain communication." As far as Manila is concerned, there is a single cable from Hong-Kong, which until last month was landed at Cape Bolinao and connected with the town of Manila by a land line some 130 miles long. In consequence, however, of this land line having been cut by the insurgents, the cable was removed from Cape Bolinao and carried direct into Manila. This cable was interrupted a few days ago, and it is rumored that the end has been taken on board an American vessel at Manila for the purpose of establishing direct communication between Admiral Dewey's fleet and the United States. For the truth of this rumor we do not pretend to vouch.

We have on previous occasions given instances of the part played by telegraph cables during various wars, and have shown with what facility these can be destroyed in shallow water. In April of 1882 we published a detailed account of the various occasions on which damage was done to the cables on the west coast of South America during the Peru and Chile war, and the effect thus produced in the course of that war.

We in England have not yet had much practical experience on this subject. It is true that during the bombardment of Alexandria, the lines across Egypt, which form the principal link in our means of communication with India, China and Australasia, were cut by Arabi's troops, but this was little noticed at the time, as telegrams could still be sent to the East across the land lines through Persia, or via those which run through Russia and Siberia. Circumstances have changed since that time. We learn that at present the Russians are displaying great activity in Northern Persia, and it is not improbable that in time of need we may find both the Persian and Siberian lines closed against us. Since the time of the bombardment of Alexandria a ring of cables has been put round Africa, which joins the submarine telegraph route to the East at Aden, thus avoiding dangers in Egypt; but these cables are notorious for the frequency with which they break down,* and could not be relied on. Some advantage might be gained by laying a series of cables to Cape Colony, via Ascension and St. Helena, and this course has been recommended as one having great strategical advantages. We cannot, however, lend much support to this theory, as this means of communication would be subject to the same danger which threatens all the existing cables to Africa, India, China and Australasia. It would be liable to be destroyed at the mouth of the channel in the vicinity of Cherbourg and Brest, where, for more than 150 miles, all these cables lie in water of a depth varying from 40 or 50 to 100 fathoms, a depth at which the cables could be cut with the greatest of ease. We have frequently pointed out the advantages which would be derived by laying a cable from Canada to Australia through the Pacific; a route far removed and naturally secured from the dangers to which the existing cables are subject in many portions of their length. Sir Charles Dilke, who is looked on as an authority in these matters, has said that British cables which followed our trade routes could be patrolled. This sounds convincing, but in time of war it is likely that the navy will have enough on its hands without telling off a large number of vessels to sail at long intervals along the lines marked down on charts as cable routes. Apart from the lack of foresight evident in this, there is an obviously false economy, as the cost of establishing independent and widely separated systems of cables would only be a fraction of that entailed by building a large number of additional cruisers to carry out a patrol duty; which, at the best, would be of little or no use as far as the protection of cables is concerned.—The Electrical Review.

* There are at present interrupted no less than four of the cable sections forming portion of the route to the Cape, via the West Coast of Africa; these are the cables connecting Mossamedes and Cape Town since April 14, Benguela-Mossamedes since April 20, Kotanu-San Thomé since April 27, and San Thomé-Loanda since May 4. Thus, with one exception, all the cables from the Gold Coast to Cape Town are now interrupted. The cable from Sierra Leone to Accra, which broke down on April 9, has since been repaired. None of the cables above mentioned are duplicated.

THE ARMIES AND NAVIES OF THE UNITED STATES AND SPAIN.

We present illustrations of the personnel of the army and navy of Spain. The Spanish army is recruited under a system inaugurated in 1885, by which all men are required to serve three years in the standing army, three years in the first and six years in the second reserve. All able bodied persons are required to enter this service at nineteen years of age, but it is possible to escape it by paying one thousand pesetas (one hundred and ninety-three dollars) and sending a substitute, especially if the person desiring to avoid service happens to possess influence. The strength of the Spanish army has been variously stated, but the following table, compiled from the latest official reports at our War Department at the close of 1897, is probably correct:

Infantryman in Cuba. Rifleman (non-commissioned officer) equipped for march. Officer of general's staff. General on parade. Lancer. Officer of infantry in Cuba. Cavalryman in Cuba. Field artilleryman.

RANK AND FILE OF THE SPANISH ARMY.

Infantry	64,314
Cavalry	14,314
Artillery	11,605
Engineers	5,102
Total active army	84,335
Sanitary and administrative	28,790
West Indian troops	201,312*
Philippine troops	37,760†
First reserves	160,000
Second reserves	1,000,000
Total peace strength	352,197
Total war strength	1,512,197

The policy of the United States is to maintain only a small standing army, and strengthen it in war time by calling upon the National Guard and the many millions of citizens who are capable of military service. The United States are divided into eight military departments, viz.: Department of the East, department of Missouri, department of California, department of Dakota, department of Texas, department of the Platte, department of the Colorado, department of the Columbia. The army is composed of ten cavalry regiments containing an aggregate of 6,457 officers and men; five artillery regiments containing 4,224 officers and men; twenty-five infantry regiments containing 13,781 officers and men; and there is a total of 3,070 in the engineer

* Army in Cuba and Porto Rico (approximate; a large portion of them in hospital).

† During late rebellion. The number probably reduced since close of rebellion.

battalion, recruiting parties, ordnance department, hospital service, signal and general service. The total figures are 2,179 officers, 25,353 enlisted men, making a grand total for the whole army of 27,532 officers and men.

In the National Guard of the whole United States there are 1,391 generals and general staff officers; 5,290 cavalry; 4,906 artillery; 101,873 infantry; making a total authorized strength of 116,125. The total actually serving according to War Department records on January 1, 1898, was 113,460.

Back of the regular army and the militia are the many millions who are available for active service should the country require them. New York State heads the list with 942,750 men. Pennsylvania comes next with 812,315, then Illinois with 700,000, Ohio with 650,000 and Indiana with 525,000. The grand total for the whole country is 10,139,788 men available for bearing arms.

The Spanish navy is small but effective. It has evidently been designed with a view to the protection of the Spanish colonies as much as the Spanish Main. The fighting line consists of one 9,900-ton battleship, the "Pelayo;" two reconstructed battleships of 7,300 tons, the "Numancia" and "Vitoria;" one armored cruiser of over 9,000 tons displacement and 20 knots speed; six armored cruisers of the "Vizcaya" type, 7,000 tons and 20 knots speed; two armored cruisers, the "Christobal Colon" and "Pedro d'Aragon," 6,840 tons and 20 knots speed; two protected cruisers, "Alphonso XIII." and "Lepanto," 5,000 tons and 20 knots; two protected cruisers, the "Reina Mercedes," of 3,090 tons and 17½ knots (the "Reina Christina," 3,520 tons, 17½ knots, was destroyed by our squadron at Manila); one wooden cruiser, the "Aragon" (sister ship to the "Castilla," destroyed at Manila), of 3,342 tons and 14 knots; three cruisers of 1,130 tons and 14 knots (sister ships to the "Don Antonio de Ulloa" and "Don Juan de Austria," sunk at Manila); and the "Marquis de Ensenada," 1,030 tons (sister ship to the "Isla de Cuba" and "Isla de Luzon," destroyed at Manila). There are also about twenty small gunboats of from 300 to 750 tons displacement and 10 to 20 knots speed. There are seven first-class gunboats of about 300 tons, built for Cuba in 1895; twenty-three second-class gunboats, 103 to 255 tons, and forty-one third-class gunboats. The navy also boasts of six torpedo boat destroyers of 28 and 30 knots speed, fourteen first-class and three second-class torpedo boats.

The most striking fact about the Spanish navy is the large number of fast armored cruisers which it possesses—its first line of battle being made up, not, as in the case of other navies, of battleships, but of cruisers.

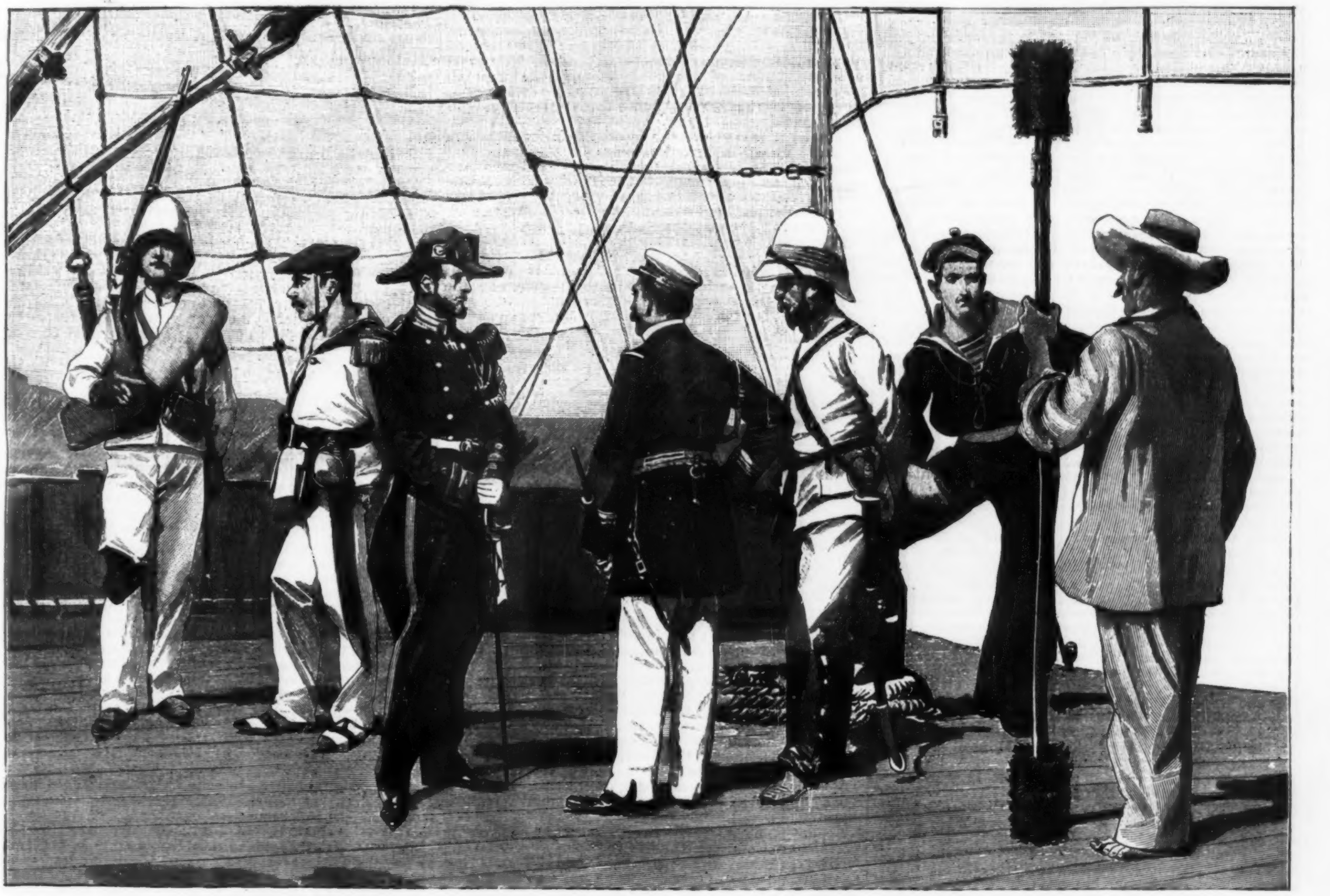
The speed of this compact fleet of nine vessels is theoretically 20 knots—its probable sea speed would be about 17 knots, or sufficient to enable it to give or refuse battle with any armored fleet that could be sent against it.

The United States navy is far more powerful than that of Spain, and as the months go by it is growing immensely stronger, owing to the fact that five new battleships are being pushed to completion. At present the fleet consists of four first-class battleships of over 10,000 tons displacement; one second-class battleship of 6,315 tons; two armored cruisers of 9,250 and 8,200 tons and 21·9 and 21 knots speed; one monitor of 6,060 tons, one monitor of 4,080 tons, and four of 3,999 tons—the battleships and monitors all carrying 10, 12, and 13-inch guns as their main armament. There are also thirteen iron monitors of from 1,875 to 2,100 tons displacement and 5 to 6 knots speed, armed each with two 15-inch smooth-bores. These are a legacy of the civil war.

The navy is strong in protected cruisers, as will be seen from the following list: First in order of size come the "Minneapolis" and "Columbia," of 7,375 tons and about 23 knots speed. Then the "Olympia," 5,870 tons and 21·7 knots; "Baltimore," "Newark," "Philadelphia" and "San Francisco," of 4,000 to 4,400 tons and 19 to 20 knots speed; "Chicago," 4,500 tons, 18 knots; "Cincinnati" and "Raleigh," 3,213 tons, 19 knots; "Atlanta" and "Boston," 3,000 tons, 15½ knots (to have a higher speed after reconstruction); the "Detroit," "Marblehead" and "Montgomery," 2,089 tons, 18½ to 19 knots speed; four gunboats of the "Yorktown" type, 1,710 tons, 16 to 17 knots speed; three gunboats of the "Helena" type, 1,392 tons, 15 to 16 knots; and two gunboats of 800 to 900 tons and 12 and 14 knots speed; six unarmored composite gunboats of 1,000 tons and 12 to 13 knots, besides a dispatch boat, dynamite cruiser and training ship. The fleet of torpedo boats is growing every month, or as fast as the craft can be completed. At present twelve are completed and fifteen are under construction. Three of the fifteen are torpedo boat destroyers of 30 knots speed.

There are also under construction five first-class battleships of 11,525 tons and 16 knots speed, two of which may be completed by the close of the year and the others some time in 1899.

The United States navy is evidently stronger than that of Spain and in a pitched battle its heavily armed and armored battleships would give it certain victory. On the other hand, Spain has a great advantage in the speed of her armored ships, and in a defensive war, unless her ships run out of coal, she could stave off the decisive conflict for many months.



Marine. Sailor equipped for boarding. Commander. Executive officer. Officer of marines in tropical uniform. Sailor. Artillerist in working uniform.

RANK AND FILE OF THE SPANISH NAVY.

NEGOTIABLE PAPER FOR PATENT RIGHTS.

THE substantial re-enactment in the "Negotiable Instruments Law," passed at the last session of the New York Legislature (Chap. 612, Laws of 1897), of the practically obsolete statute of 1877 requiring the insertion of the words "Given for a patent right" in negotiable instruments taken therefor, seems unnecessary at the present day and inharmonious with the progressive spirit of the new law, but it serves as a forcible reminder of the notorious patent right swindles which first called legislation of this character into existence. The evil reached its height, and indeed may be said to have had its life, in the Middle and Western States during the period of prosperity and wild speculation which followed the civil war. The most glaring frauds were committed; large sums were paid for rights under void and worthless patents; patent rights for the same territory were sold over and over again; notes were taken to facilitate the sales, immediately discounted, and, by the time the purchaser discovered the deception, were in the hands of bona fide holders, enforcible against the maker. The courts were powerless to protect the victims of these and other similar impositions, and the State Legislatures were finally appealed to for relief, with the result that, in 1868, Ohio passed an act which required any person, before offering for sale a patent right for any county, to submit the patent to the probate judge of the county and make affidavit before him that the patent was in force and that the applicant had the right to sell, and also requiring that any written obligation taken on the sale of such right should bear on its face the words "Given for a patent right." Failure to comply with the law was made an offense.

That this statute in its entirety was of doubtful propriety seems to have been realized, for within a year the provision requiring the making and filing of proofs was repealed. But the legislation was of the infectious character, and the Ohio statute in substantially its original form was made the law of Indiana and Illinois in 1869, of Minnesota in 1871 and of Nebraska in 1873, Kansas following their example as recently as 1889, while the law as amended in Ohio, requiring only that written obligations given for a patent right should bear such statement on their face, was passed by the legislatures of Vermont in 1870, of Michigan in 1871, of Pennsylvania and Wisconsin in 1872, of New York and Connecticut in 1877, and of Arkansas in 1891.

In the litigation which promptly followed the enactment of the statutes their constitutionality was assailed vigorously, and at first with uniform success. The first decision of importance was rendered in 1870 by the Hon. David Davis, then an associate justice of the Supreme Court of the United States, in Ex parte Robinson (2 Bissell 309), on a petition for a writ of habeas corpus. The petitioner had been arrested under the Indiana statute for offering a county right for sale without having first filed a copy of the patent and proofs required by the law. The ground of the petition was the invalidity of the statute, and Justice Davis held that the enactment was an attempt to prohibit the sale of patent rights, if the directions were not complied with, and to throw burdens on the owners of such property which Congress had not seen fit to impose upon them; that Congress under the authority given to it by the Constitution had directed the manner in which patents should be assigned and sold; that property in inventions existed by virtue of the laws of Congress and that no State had a right to interfere with its enjoyment or annex conditions to the grant; that a patentee had the right to go into the open market anywhere in the United States and sell his property; that if this were not so, a State might

impose terms which would prohibit any sale, and thus nullify the laws of Congress and destroy the power conferred upon it by the Constitution; and that the law in question attempted to punish by fine and imprisonment an act which the national legislature had authorized, and was therefore void, and the petitioner was discharged.

The Supreme Court of Illinois, in 1873, of Minnesota, in 1876, and of Nebraska, in 1883, following the decision in Ex parte Robinson, declared that statutes substantially the same as that of Indiana were void (Hollida v. Hunt, 70 Ill. 109; Crittenden v. White, 23 Minn. 26; Wilch v. Phillips, 14 Brown, Neb. 134); but in 1885 the Supreme Court of Indiana decided that the authority of Ex parte Robinson had been overthrown by the Supreme Court of the United States, in 1878, in Patterson v. Kentucky (97 U. S. 501), and overruling its own previous decision (Helm v. First National Bank, 43 Ind. 167), in which the section of the act relating to negotiable instruments was declared void, sustained the section of the statute requiring the filing of proofs (Brechbill v. Randall, 102 Ind. 528), and this decision was followed in the later Indiana cases, New v. Walker (108 Ind. 366) and Sandage v. Studebaker (142 Ind. 148), and also in Kansas (Mason v. McLeod, 57 Kansas 108).

The conflict between these authorities is direct and irreconcilable. The statute has been sustained by the Supreme Courts of Indiana and Kansas, but it has been declared invalid by courts of equal standing in Illinois, Minnesota and Nebraska, as well as by the Federal Court in Indiana. The weight of reason and of authority are decidedly against the validity of the statute. It cannot be denied that a law which requires the owner of a patent right or his agent to appear personally before an official in every county of the State, and make and file with him an affidavit and a copy of his patent before offering to sell a State right, is an onerous restriction upon the enjoyment of the property right secured to him by Congress. Nor can it be properly said that the offering of a patent right for sale honestly and fairly, irrespective of the character of the patent, is per se an act so harmful to the welfare of the community as to justify its prevention or regulation by the exercise of the police power of the State. It is true that the Supreme Courts of Indiana and Kansas have decided otherwise, but these decisions are both based upon the erroneous propositions first enunciated in Brechbill v. Randall (supra), that the Supreme Court of the United States, in Patterson v. Kentucky, held that the sale of the incorporeal rights granted to a patentee may be regulated by a State under the proper exercise of its police power, and that the same case overruled Ex parte Robinson. What the Supreme Court did hold was that the prohibition of the sale of an illuminating oil, which it was admitted could not possibly be made to conform to the State standard of safety, was a proper exercise of the police power of the State, and the mere fact that the oil was patented did not relieve the patentee from a compliance with the State requirements. The court recognized the difference between the incorporeal right secured by the patent and the right to sell the patented article, and expressly decided that the former "may be secured and protected by national authority against all interference." Instead of overruling Ex parte Robinson, that decision was tacitly approved.

Quite as serious is the conflict as to the law requiring the insertion in written obligations of the words, "Given for a patent right," adopted by the States of Vermont, Connecticut, New York, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Kansas, Arkansas and Nebraska. It has been declared unconstitutional by the highest State courts in Indiana (since overruled), Illinois, Michigan, Minnesota and Nebraska and by the United States Circuit Courts in the Southern District of Ohio and in the District of Indiana (Helm v. First National Bank, 43 Ind. 167; Hollida v. Hunt, 70 Ill. 109; Cranson v. Smith, 37 Mich. 309; Crittenden v. White, 23 Minn. 24; Wilch v. Phillips, 14 Brown (Neb.) 134; Woollen v. Banker (U. S. Ct. Ct. Ohio) 2 Flippen 33; Castle v. Hutchinson (U. S. Ct. Ct. Ind.) 25 Fed. Rep. 394); while its validity has been sustained by the courts of last resort in New York, Pennsylvania, Ohio, Indiana, Kansas (Herdic v. Roessler, 109 N. Y. 127; Haskell v. Jones, 86 Pa. St. 173; Shires v. Commonwealth, 120 Pa. St. 368; Tod v. Wick Brothers, 36 Ohio St. 370; New v. Walker, 108 Ind. 366; Sandage v. Studebaker, 142 Ind. 148; McLeod v. Mason, 57 Kansas 108). On this point, while the rulings of the courts are more evenly balanced, it is believed that those against the validity of the law preponderate. The Indiana decision (New v. Palmer), followed in Kansas, held that the enactment of the statute was a proper exercise of the police power resident in the State; but, as pointed out, Patterson v. Kentucky, relied upon as authority for this proposition, does not sustain it. The New York Court of Appeals in Herdic v. Roessler (supra) withheld its approval of the Indiana and Kansas doctrine, and, following the Ohio and Pennsylvania decisions, held that, while a State law which interfered with the exclusive right granted to inventors would be void, the New York statute did not interfere therewith, as it operated only upon the thing taken for the right when that was a negotiable instrument. It is true that primarily it does operate upon the thing taken, but it also operates upon the patentee's chance of disposing of his property, and places and was intended to place a restriction upon the free and unrestricted right to transfer it given to him by Congress. That was the sole object and purpose of the law, which says to the owner that he may not, under pain of fine and imprisonment, sell his property, his incorporeal right, and take therefor a promissory note, entitled to the special protection afforded to negotiable paper by the law merchant. If this be lawful, the State may lawfully place its prohibition upon other forms of contract and other descriptions of consideration, imposing terms "which would result in a prohibition of the sale of this species of property within its borders and nullify the laws of Congress."

Until, however, the validity of these statutes is brought before the United States Supreme Court—if that should ever be—their validity must be regarded as finally established, as far as the State courts of New York, Pennsylvania, Ohio, Indiana and Kansas are concerned. That they will be declared unconstitutional and void, if ever brought before the Supreme Court, is hardly to be doubted. That has been the attitude of every Federal judge who has passed upon the question.

[Continued from SUPPLEMENT, No. 1170, page 18730.]

KITES: THEIR THEORY AND PRACTICE.

By Capt. B. F. S. BADEN-POWELL, Scots Guards.

II. THEORETICAL PRINCIPLES.

THE theoretical principles of kite flying seem to have received but little attention from scientists. Professor C. F. Marvin, of Washington, has recently published two monographs, "Kite Experiments at the Weather Bureau" and "The Mechanics and Equilibrium of Kites," which practically constitute the entire literature (in English) on the subject, except for a few remarks in Mr. Chanute's interesting work, "Progress in Flying Machines," and in the "Aeronautical Annual, 1896," while the scientific researches of Professor S. P. Langley ("Aerodynamics") also throw great light on the subject.

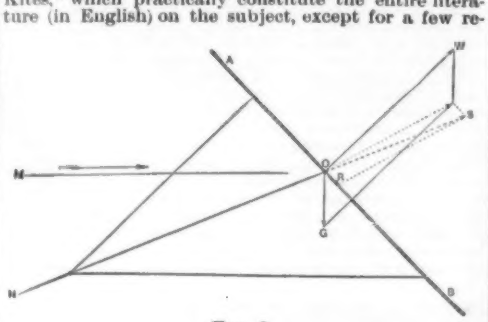


FIG. 3.

In order to investigate the results of the forces acting on a kite, we will assume that it is a flat plane, and that the wind blows in a steady, horizontal course. These conditions are practically but seldom met with, the kite surface usually forming a variety of curves and planes at various angles, while the wind is always variable both in force and direction.

There are two forces acting on the kite in opposition to the retaining line, viz., the wind and the weight of the kite. The wind acts in several ways: it presses on the whole under surface normally to the general plane of the kite; it acts on the front edges and on any projection, tending to drive the kite in the direction of its central vertical axis; and it acts on the retaining line. There may also be a certain amount of "skin friction," though this is probably a very unimportant factor.*

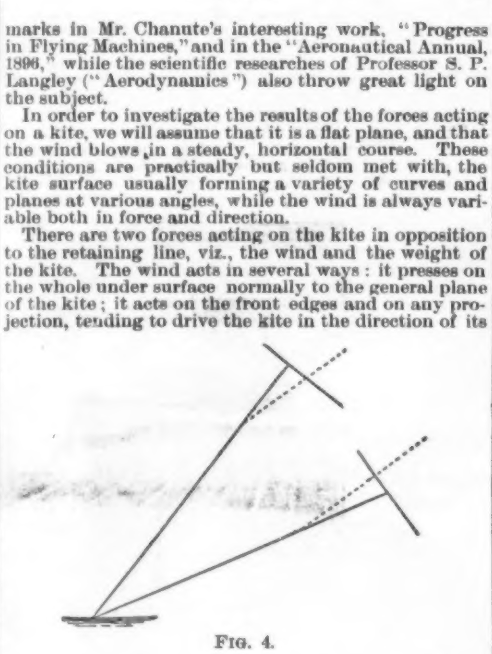


FIG. 4.

In Fig. 3 let A B represent a vertical section of the kite; O W the wind pressure, which will be at right angles to the plane of the kite; O G represents gravity, or the weight of the apparatus; O R the "frontal pressure," that is, the edge resistance of the kite and cords and all projections to the wind. Then, by completing the parallelogram, we get O S for the total resultant, which gives the force and direction which the string has to oppose in order that the kite shall remain in equilibrium.

From this figure it will readily be apparent how important are the proportionate relations of weight and frontal pressure to the effective wind force, in that, as the latter (O W) increases, the total resultant, or direction of pull, becomes more and more perpendicular to the kite. Hence, with a heavy kite in a very light wind, the string will pull at such an angle that the kite cannot rise to any great height.

As the kite rises in the air, pivoted about the base of the string, the direction of the wind force remains the same—that is, normal to the surface—but it lessens in intensity as the angle presented by the kite becomes smaller, while, on the other hand, the force of gravity or weight remains the same in intensity, but becomes more perpendicular. The frontal pressure, as a rule, increases slightly. Therefore, as the kite approaches the zenith, the total resultant becomes more at right angles. (Fig. 4.)

On starting the kite, the string will naturally be nearly horizontal, as M O. The direction of pull being O S, the kite will rise upward, until the string comes in the position, O N. If it rises above this, it will, of course, be blown back to the position, O N.

Hitherto we have taken the point, O, as the center of effort of the wind. But in practice this exact point is not easy to find. Moreover, as will presently be shown, it shifts about according to the angle of the plane. To overcome this practical difficulty a "bridle" is used. This consists of strings fixed on the kite at points above and below the place of the center of effort and connected in the ground line. The use of the bridle, then, is to automatically adjust the direction of the pull of the string toward the center of effort.

The action of this contrivance can be more easily understood if we suspend a rod horizontally by a piece of string fixed to its center. If a weight be hooked on to the rod on one side of its center, it at once tips up. The same occurs with a kite in which the string is affixed to one point—directly the wind force is greater on one side than the other, the kite must tip up. But now if we put a bridle on the rod, i. e., suspend it by two strings fixed apart on the stick, and held together above it, a weight can be hooked on to any point between the strings without the rod tipping up to any great extent. Under such circumstances the rod will be inclined until the weight (or rather the center of gravity of the whole) hangs just below the point of suspension. In the kite this means that such an angle will be presented to the wind that the pull of the string will point toward the center of pressure.

With a plane surface placed at right angles to a current of wind, the center of the figure will be the center of effort, and it would be comparatively easy thus to determine the exact center of effort of any given kite were it not for a law of nature only recently determined, which is, that as a plane presents a less angle to a fluid impinging upon its surface, the center of pressure moves forward toward the front edge of that plane. Therefore, as a kite rises in the air the angle it presents to the wind becomes less, and therefore the center of pressure shifts forward.

The experiments of Langley, Joëssel, and Kummer practically agree in showing that the center of effort works forward of the center of area according to the formula

$$d = (0{\cdot}3 - 0{\cdot}3 \sin \alpha)\ L$$

L being the length of a square plane, which may, of course, give a slightly different result to the ordinary shape of a kite.

I have already referred to the "diedral" angle of a kite giving stability. The reason for this is easily demonstrated.

A B C (Fig. 6) represent a horizontal section of a kite having a considerable diedral angle. The arrows show the direction of the wind force against the two sides. Now, in strong winds many twirls and eddies are found in the wind currents, just as one sees them in a rapid-flowing river. Such eddies cause uneven pressures to be produced on different parts of a kite. If then a greater pressure is suddenly brought to bear on the side, A B, this side is driven back, and a smaller angle is presented to the wind; while the other side, B C, is pressed forward, and, by becoming more at right angles to the direction of the wind, takes a greater pressure, and thus equilibrium is automatically restored.

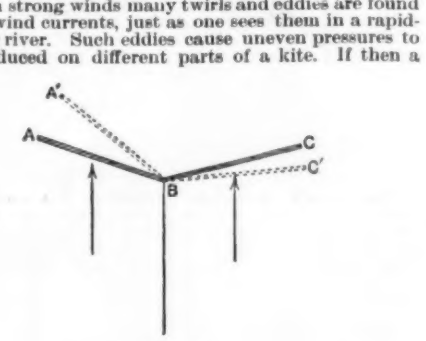


FIG. 6.

It has been pointed out that this form of kite has less tendency to rise high; the reason of this, too, is explicable. The bending back of the sides, of course, diminishes the effective area of the kite—that is, wind pressure is diminished; but the weight and frontal pressure remain the same. Hence the resultant pressure acts less perpendicularly.

Curved Surfaces.—We began by assuming that the kite was a flat plane, which it seldom is in practice. The action, however, of a current of air impinging on a curved surface is one very little understood. I think we can explain the action of a kite whose whole vertical section consists of one concave curve, and which, as I have said, in practice is always inclined to "top" over into the wind. On the principles already explained, we can understand how the pressures toward the upper portion of the curve, when the surface presents a small angle to the wind, are advanced forward, and that the result will be a strong upward pressure. When the kite has risen to a given height, the angle presented by the front portion of the curve will have become less and less, owing to the direction of the pull of the string, until it is absolutely horizontal, and then not only is there no pressure on the front part of the kite, but the wind will pass over the top, and cause the flexible material to shiver and bag, so that all buoyancy is lost, and it then naturally rolls over and spills out its wind.

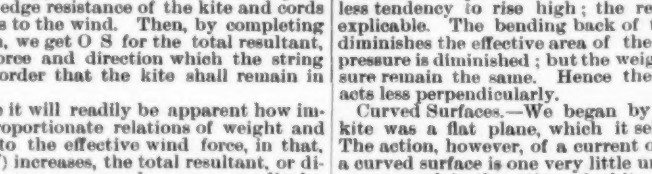


FIG. 5.

Duplex Lines.—The theoretical advantages of "duplex" lines can be explained in the same manner as those of the bridle. If a horizontal section of the kite be taken, it will be like the rod suspended by a string from the center. If the wind pressure comes on one side, the stick or crosspiece of kite is tilted over. This

* "The friction of the air is inappreciable. This fact may be stated as the result of my own experiments, and of well known experiments of others."—Prof. Langley's "Aerodynamics."

will at once cause the whole kite to be driven away to one side, and thus in a variable wind the kite will be continually moving from side to side. Directly, however, we suspend the rod by two strings, it is apparent that no shifting of the weight or pressure can cause it to move. (See Fig. 5, No. 4.)

Tail.—It may be as well to inquire into the raison d'être of the tail. It is not likely to have been applied to kites all these years without some reason. Now we know that a badly constructed kite is liable to turn over and dive to the ground, or swing from side to side. How can this be prevented? If the lower end can be kept down and back, the kite cannot capsize. If a heavy weight were attached to the bottom of the kite, any irregular movement would set it swinging like a pendulum, and this action would probably be increased until the kite revolved right round. Moreover, the weight would simply tend to pull the kite straight downward toward the ground. On the other hand, if a long, light tail were attached so as to be driven back by the wind, it would have a tendency to pull the kite flat. By combining the two, judiciously adding weight to a long tail, the desired result may be obtained of rectifying the faults of a badly constructed kite.

It is often difficult to get practice to agree with theory. Thus, for instance, according to theory, if the wind is blowing about 50 miles an hour, the pressure on a plane surface at right angles to it should be at the rate of 12 lb. per square foot. Thus on 100 square feet it should be 1,200 lb. But if the angle be inclined, even to 30° with the horizon, the normal should be 0·8 of this, that is, 960 lb. Practically, however, though I have had out kites to test their pull during strong gales, I have no record of a 100 foot kite ever pulling more than 250 lb. on the string, and this amount is quite exceptional.

When considering what weight can be lifted by a kite, and to what height it can be raised, the forces acting on the string must be considered. These forces are the weight of the line and the presence of the wind upon it. These cause the line to hang in a curve, more horizontal near the ground and more perpendicular near the kite. The total force thus acting tangent to the string (commonly called the "pull) may be divided into two forces of "lift" and "drift," that is, a force acting vertically upward and one acting horizontally in the direction of the wind. Now it can readily be understood that the "lift" is greater in proportion near the kite than near the ground, while the "drift" may become so great near the ground as to pull the line horizontally, and not even lift it off the ground. But on comparatively short lines and in a good wind, this curve is not of importance. We have, however, to consider the effect of hanging a heavy weight on the line. That portion above the weight will remain at the angle caused by the pull of the kite. But the angle of the string below can be readily found.

The above paper was read before the Society of Arts and published in the Journal of the society.

SEWAGE DISPOSAL.*

By BENJAMIN F. LA RUE.

THE growth of urban population has been very rapid during recent years, showing a remarkable increase in the population of nearly all cities and towns, but more especially of the large cities. This condition has rendered more complex the problems confronting the civil engineer working along the lines of water supply and sewerage. The rapid increase of population greatly augments the flood of sewage poured into the streams, polluting the natural sources of water supply, and also intensifies, to a corresponding extent, the demand for pure water.

Sewage is the term applied to the solid and liquid wastes of the human economy, as well as to street washings and factory wastes, and also to the water combined with them for the purpose of removal. The popular idea regarding sewage is simply that it is something so essentially repulsive that it must be kept entirely out of sight; and the old principle of out of sight out of mind applies. So long as the sewage does not offend the popular senses, it receives little popular attention.

This attitude of the popular mind in regard to sewage is radically wrong and has much retarded the development of sewerage as a science. The waste of the human system is as certainly a vital and unavoidable fact of existence as is the food on which it subsists; and the important problem of disposing of the waste under sanitary conditions should neither be evaded nor ignored, but should be met fairly and dealt with upon its merits.

In most country districts and small villages, and in many outlying suburbs, the sewage is discharged into vaults and cesspools, where it remains to putrefy, contaminating the surrounding earth and atmosphere. Though producing the most unsanitary conditions, it is hidden from view, and, consequently, receives no further attention. In cities, the sewage is removed promptly by the sewers before offensive conditions can arise. So far as the popular mind is concerned, it has disappeared; what more can be desired? That the sewers are merely conduits for removing the sewage to other localities, and that the sewage thus removed may produce offensive, unsanitary and even dangerous conditions in the localities where discharged, are features of the matter having little popular interest.

The most common method of disposing of sewage is to discharge it into the nearest stream or other body of water. This method of disposal is convenient and cheap, and, under proper conditions, is permissible. If, however, where this method of disposal is employed, the discharged sewage forms more than a very small fraction of the total volume, the water may become so polluted as to be not only wholly unfit for any domestic use, but also a dangerous menace to towns whose water supplies are derived from the same streams lower down. The objections of such towns to the pollution of their water supply, and the legal proceedings that have in some cases been instituted to prevent it, have done much toward directing attention to other forms of sewage disposal.

That every riparian proprietor is entitled to have the stream on which his realty is situated flow past his domain in its natural course and condition is an old and well-established principle of law; and from this principle is derived directly the almost equally well-established doctrine that to pollute a public stream is to maintain a common nuisance. Although the necessities and conditions of modern society require some deviation from the strict letter of this broad principle, it is accepted as being, on the whole, sound legal doctrine. The Royal Sanitary Commission of Great Britain, created in 1869, recommended that any stream from which drinking water is taken should be effectually protected from sewage pollution. The spirit of this recommendation is in harmony with the attitude of the law and is quite generally considered as one of the fundamental principles of sanitary engineering. It has been gradually extended to include all streams that are likely to become sources of water supply by at least the provision that, if sewage be discharged into such streams, it shall be under such conditions that the pollution can be terminated whenever the water is required for domestic purposes. There is a growing sentiment in favor of protecting the streams and small inland lakes from pollution by town sewage. For it is realized that this is necessary if, as the density of population increases, we are to continue to have a supply of pure drinking water.

The more dense the population becomes, the greater will be the supply of water required, and, at the same time, the greater will be the discharge of sewage and consequent pollution of streams. The harmonizing of these two opposing influences presents a problem that is by no means insignificant at the present time, and in the future is likely to assume such proportions as to considerably modify social conditions. In the arid and semiarid regions of the West the supply of water must, even under present conditions, be carefully husbanded; and if, in those regions, the population ever becomes exceedingly dense, it will be necessary to utilize every drop of the available supply—a condition that will render the proper and sanitary sewerage of the region extremely difficult. In some parts of the East the population has already become so dense and the water supply so affected by sewage pollution as to give the matter a serious aspect and make remedial measures necessary.

The remedy employed for the amelioration of this condition is sewage purification. The sewage effluents are purified and rendered as nearly innocuous as possible before being discharged into the streams. A number of sewage purification plants have been established in various parts of the country, and the results obtained have been, in most cases, highly satisfactory. Indeed, so high a degree of purification has been reached in some cases as to render the purified sewage effluent chemically purer than the average supply of drinking water, and there appears to be no reason, other than popular sentiment, why such a purified effluent may not, with perfect safety, pass into a stream from which a public water supply is obtained. The very valuable experiments of the Massachusetts State Board of Health have shown that there is no difficulty in removing from 95 to 99½ per cent. of the organic impurity. In view of the great importance of the subject, it will be of interest to notice briefly the most common methods of sewage disposal and some of the means employed for purification.

Those methods of disposal that have been tested on any considerable scale, and have proved to a reasonable degree successful, may be classified as natural disposal, clarification and application to the soil. Space permits here only a brief notice of these different methods of disposal.

Natural disposal and dilution are terms sometimes used to designate the practice of discharging sewage directly into a stream or other body of water without previous treatment. This method of disposal, being both cheap and convenient, has been extensively employed, and, under proper conditions, its results may be neither offensive nor unsanitary. When untreated sewage is discharged into a stream of water, the water immediately below the sewer outlet will be rendered extremely impure. But if the water is of sufficient volume in comparison with the volume of sewage discharged into it, and is sufficiently in motion, exposing it to the action of the atmosphere, a change will take place and the water will gradually become purified, so that, at a distance of a few miles below the sewer outlet, all traces of the sewage will have disappeared. Not only will the sewage become very highly diluted by the comparatively great amount of water, but a certain degree of actual change, or purification, will also take place.

This change, which is sometimes called self-purification, is due to several causes. Some of the organic matter becomes food for aquatic vegetation and animal life; some combines chemically with the oxygen of the air and water, forming inorganic compounds; more or less chemical change is due to the presence of micro-organisms; while much of the solid matter is separated and deposited in particles along the bed and banks of the stream. The greater the comparative volume of the water and the swifter its current—giving greater exposure to the atmosphere—the more rapid and effectual will be the purification. The degree of purification that can be obtained by this method of disposal is quite uncertain, however, and it would be extremely hazardous to discharge untreated sewage into a stream used as a source of public water supply. It is safe to state that this method of disposal is employed in very many cases where it ought not to be.

Clarification consists in removing the greater portion of the solid matter and, by some processes, a portion of the dissolved matter from the liquid sewage before discharging it into a stream or other body of water. The effluent, though by no means approximating pure water, is much less objectionable than the original sewage. The degree of clarification obtained will depend upon the process employed and the thoroughness of its application. Three general processes of clarification are employed, namely, sedimentation, mechanical filtration and chemical precipitation.

By the process of sedimentation, called also subsidence, the sewage is collected in tanks or reservoirs and allowed to stand until the solids have settled to the bottom, after which the water is drawn off slowly, discharging into a stream or body of water. The effluent, though somewhat clarified, still remains highly charged with impurities.

By the ordinary processes of mechanical filtration, the sewage is simply passed through filters or screens of various kinds. Such processes remove a larger proportion of the solid matter than can be removed by subsidence, but leave the effluent still very impure.

Chemical precipitation is the direct outgrowth of unsatisfactory sedimentation. The sewage is collected in tanks or reservoirs, and with it are mixed certain chemical solutions which precipitate not only the solid matter, but also a portion of the matter held in solution. Various chemical processes are employed, a large number of which have been patented. The effluent from sewage clarified by any process of chemical precipitation is, however, far from being pure water, and is liable to decompose after being discharged into a stream. Moreover, the addition of the chemicals used is more or less deleterious to the water. This method of purification is not of itself sufficient where the effluent is to be discharged into a stream from which a public water supply is obtained.

VIEW OF A CORNFIELD ILLUSTRATING IRRIGATION BY SEWAGE.

Application to the soil is, beyond question, the most satisfactory and effectual means of purifying sewage. Those natural waters that have undergone prolonged filtration through the soil are the most free from organic matter. As the water passes through the soil, the organic matter is obstructed and retained, or taken up by vegetable growth. Under favorable conditions, water may become highly purified by this means, though it is still uncertain whether water that has been contaminated by sewage can be rendered so pure as to be safe for domestic use. It may be of interest, however, to notice that the managers of the Berlin sewage farms are said to have stated that, although the workmen are strictly forbidden to drink the water from the sewage effluent, it is impossible to prevent them from doing so.

In applying sewage to the soil for the purpose of purification, two general processes are employed, namely, broad irrigation and intermittent filtration.

Broad irrigation is the most satisfactory and effectual means of sewage purification yet tried, where sufficient suitable land can be procured. It includes quite a variety of methods, differing more or less in detail, all of which consist, essentially, in applying the sewage in such manner and quantity as to irrigate and fertilize the soil for the growth of vegetation. This appears to be the most natural and economic method of sewage purification, involving the familiar processes of decomposition and growth under natural conditions, and utilizes by irrigation and fertilization the full economic value of the sewage. As the amount of sewage that can be applied to a given area, however, without being detrimental to the growing crops, is limited, this method requires extensive areas; hence the name broad irrigation. In the vicinity of large cities land is very valuable, and in order to require less areas, a modification of this method is employed. It should be stated, however, that it may be seriously questioned whether greater profits cannot be obtained from land utilized for irrigation than have yet been obtained in America, thus permitting the use of more valuable land for this purpose. In order that renewed supplies of oxygen may enter the soil to maintain the oxidizing processes, the application of sewage, commonly spoken of as the dose, must be intermittent. If, without regard to the requirements of vegetation, the amount and frequency of the dose is increased to nearly the full capacity of the soil, the irrigation will be converted into intermittent filtration.

* From Home Study Magazine.

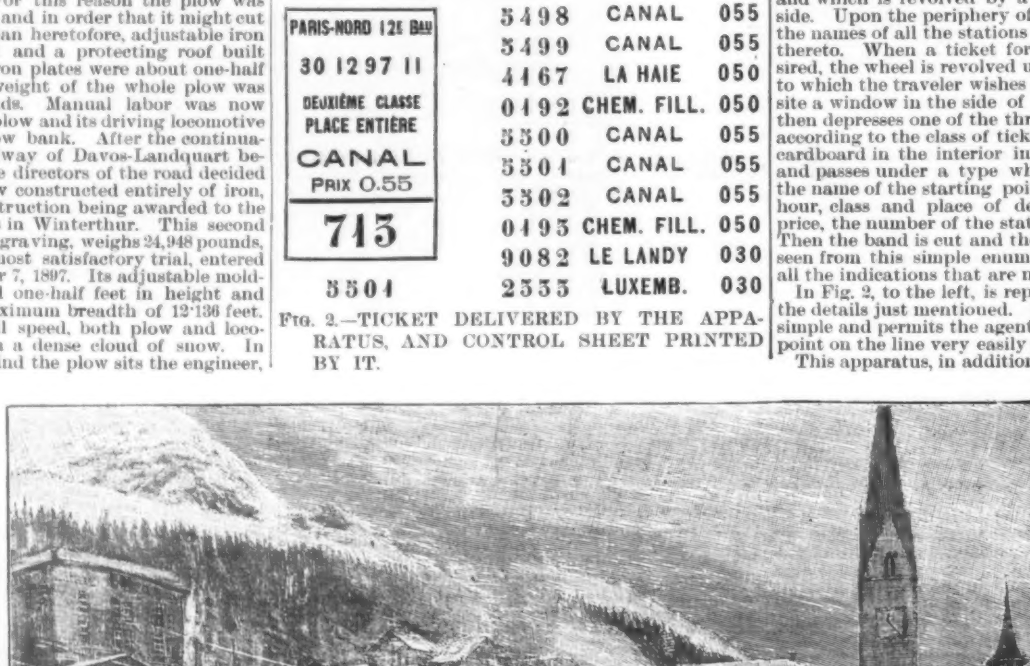
Intermittent filtration may be considered as copious irrigation devoid of its utilitarian features. Both upward and downward filtration have been tried, the latter having given the more satisfactory results. The sewage is flooded upon ground that has been prepared for the purpose and thoroughly underdrained, and is filtered by passing downward through the soil to the drains. The filtration is not merely mechanical, however, but is largely a chemical process. While the soil, to some extent, acts as a mechanical filter in straining out portions of the solid matter, the purification is chiefly of the nature of chemical change, involving oxidation and nitrification, brought about largely through the agency of micro-organisms called bacteria, contained in the sewage.

It is thus seen that the sewage contains within itself the means of its own purification, and, when the proper conditions are present, virtually becomes its own purifier. Under the favorable conditions afforded by intermittent filtration, purification is effected by the bacteria; and these minute organisms, having performed their important work, finally succumb to the action of oxygen and wholly disappear. If the filter beds are properly prepared and the application of sewage properly regulated, the beds will not become fouled and ineffective by use, but will, within limits, become more and more effectual.

These facts, though pertaining to an unattractive subject, relate to some of the most beautiful and interesting of nature's processes; they are worthy of more attention than they have received, and should be more fully investigated and more generally understood. They illustrate, too, the universal principle that in the workshop of nature there is no room for a sluggard. Every individual entity, however minute, has its work to perform, and, having completed that work, the inflexible laws of nature's economy require that it shall no longer exist in that particular form, but shall pass to another state of existence in which it may again be useful.

THE NEW SNOW-PLOW OF THE RHÆTIAN RAILWAY.

During one of the snowy winters shortly after the completion of the narrow railway which follows the road upward to Davos in the beautiful valley of Landquart, strong battalions of laborers had to be telegraphed for to Prätigau and the neighboring valleys in order to keep the tracks clear between the trains. The first snow-plow of the Landquart-Davos railroad was built of wood, and might have performed very excellent service on level surfaces; but against great barricades of snow thousands of yards in length it could make no impression. For this reason the plow was covered with iron plates, and in order that it might cut a still broader passage than heretofore, adjustable iron moldboards were added and a protecting roof built for the engineer. The iron plates were about one-half an inch thick and the weight of the whole plow was increased to 33,000 pounds. Manual labor was now required only when the plow and its driving locomotive were stuck fast in a snow bank. After the continuation of the Rhætian railway of Davos-Landquart beyond Chur to Thusis, the directors of the road decided to employ a second plow constructed entirely of iron, the contract for its construction being awarded to the Swiss Locomotive Works in Winterthur. This second plow, illustrated in our engraving, weighs 24,948 pounds, cost \$2,700, and, after a most satisfactory trial, entered Davos-Platz on December 7, 1897. Its adjustable moldboards are almost six and one-half feet in height and can clear a road to a maximum breadth of 12·136 feet. When working under full speed, both plow and locomotive are enveloped in a dense cloud of snow. In the well heated car behind the plow sits the engineer, his watchful eye constantly fastened upon the snow-covered road before him; without changing his place, he gives his commands through a speaking-tube to his colleague in the locomotive behind. Of the men who assist him, two attend to the heavy mechanism of each moldboard; the others keep a watchful eye on the road, and are ready at any moment to hurry forward and perform some pressing task. If the snow-plow runs into a great drift that defies all efforts of the puffing locomotive, then, even to this day, messengers have to work their way in both directions in order to procure much needed assistance.—Illustrirte Zeitung.



THE NEW SNOW-PLOW OF THE RHÆTIAN RAILWAY.

APPARATUS FOR DISTRIBUTING RAILWAY TICKETS.

As well known, in order to purchase a ticket at a railroad office, it often happens that a person has to fall into line behind a number of others and await his turn to reach the agent's window. Although the time seems to pass slowly, the handing out of the tickets is, nevertheless, done pretty rapidly, considering the number and variety sold. On some of the French lines, where the multitude of way stations and the sale of full rate, half rate, quarter rate and round trip tickets necessitates the handling of a large number of different kinds, the operation is not performed quite so rapidly. In order to expedite matters in this regard, the Compagnie des Chemins de Fer du Nord and the Compagnie de l'Ouest have recently placed on trial a new and ingenious apparatus designed to distribute first, second and third-class tickets upon short lines.

Fig. 1.—APPARATUS FOR DISTRIBUTING RAILROAD TICKETS.

In order to complete the series of tickets mentioned above, it would be necessary to juxtapose several apparatus. The general principle of the device is, briefly, as follows: At the top of the apparatus there is a large cylinder around which are wound strips of cardboard and which is revolved by a wheel placed at the left side. Upon the periphery of this wheel are inscribed the names of all the stations and the cost of the fare thereto. When a ticket for a certain station is desired, the wheel is revolved until the name of the place to which the traveler wishes to go presents itself opposite a window in the side of the cylinder. The agent then depresses one of the three handles placed in front, according to the class of ticket asked for. The strip of cardboard in the interior immediately detaches itself and passes under a type wheel which prints upon it the name of the starting point, the date, month, year, hour, class and place of destination, as well as the price, the number of the station and a series number. Then the band is cut and the ticket drops. As may be seen from this simple enumeration, the ticket carries all the indications that are necessary.

PARIS-NORD 12E BAU
30 12 97 11
DEUXIÈME CLASSE
PLACE ENTIÈRE
CANAL
PRIX 0.55
713

5501

5498	CANAL	055
5499	CANAL	055
4167	LA HAIE	050
0192	CHEM. FILL.	050
5500	CANAL	055
5501	CANAL	055
5502	CANAL	055
0193	CHEM. FILL.	050
9082	LE LANDY	030
2333	LUXEMB.	030

Fig. 2.—TICKET DELIVERED BY THE APPARATUS, AND CONTROL SHEET PRINTED BY IT.

In Fig. 2, to the left, is represented a ticket with all the details just mentioned. The manipulation is very simple and permits the agent to obtain tickets for every point on the line very easily and very quickly.

This apparatus, in addition to the great services that it renders as a distributer of tickets, acts as a registering machine. At the moment that it detaches the ticket all prepared, with the necessary indications, a strip of paper unwinds and receives the series number of the ticket, the place of destination and the price

charged. All the figures are arranged one beneath another, and it suffices to add them up in order to verify the amount received within a certain period of time. A portion of one of these control slips may be seen to the right in Fig. 2.

Let us add that the date is printed so conspicuously as to render the use of a ticket good only for the day issued impossible. For the illustrations and the above particulars we are indebted to La Nature.

LADLE CRANE FOR STEEL WORKS.

WE illustrate on this page a crane specially intended for use in a Bessemer plant which has been constructed and designed in the Ateliers de Construction de la Meuse, Liège. The general appearance of the crane is

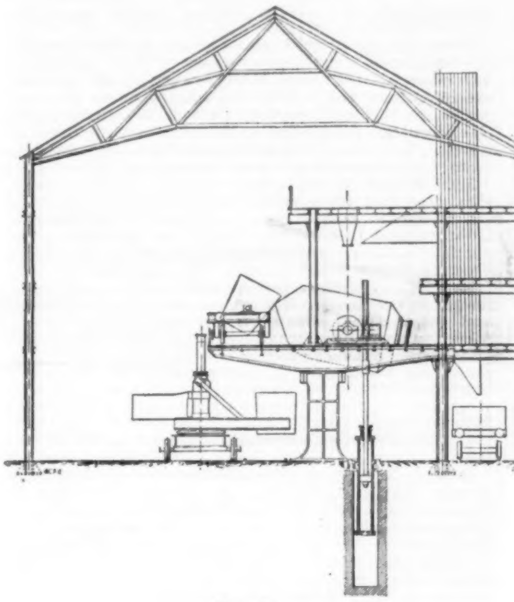


FIG. 2.

well shown in Fig. 1, while in Fig. 2 is shown the arrangement of the converter house in which it is intended to be used. The ladle bringing the cast iron to the converter is carried on a truck running on rails fixed to cantilever extensions of the beams supporting the converter, while the spiegeleisen, magnesia, etc., can be charged from an upper platform, as shown. At the back is a chimney into which all the slag, etc., projected from the converter during the blow, passes and is collected in the wagons below. When the blow is finished the contents of the converter are emptied into the ladle carried by the crane, illustrated in Fig. 1, which is turned round for the purpose as shown in Fig. 2. This crane then carries the molten metal to the ingot moulds, which are arranged in immediate proximity to the plate mills. The ladle can be raised by hydraulic power, the crane being fitted with the necessary pumps. Two attendants control the whole of the operations, one attending to the traversing of the crane and the other manipulating the ladle.—We are indebted to London Engineering for the cuts and description.

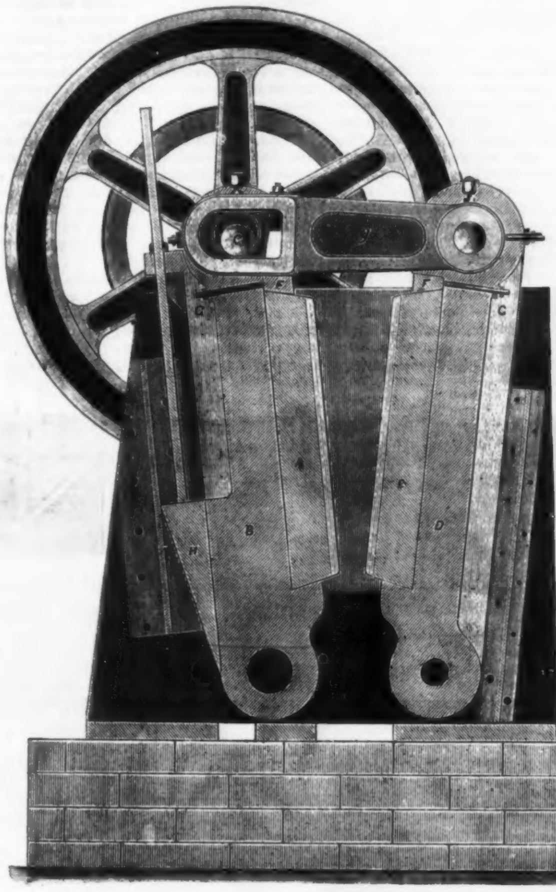
FIG. 1.—LADLE CRANE FOR STEEL WORKS.

THE JELMAN-WEPP CRUSHER.

IN crushers of the Blake type, the stationary jaw is placed in the interior of the frame that incloses the movable one, which is generally jointed at the upper part. The cast steel facings that constitute the working parts of these jaws are naturally the ones that are subject to wear, and so it becomes necessary from time to time to replace them. On such occasions a portion of the apparatus has to be taken apart, and, as it is a question of heavy pieces to be handled, the operation is lengthy and tiresome.

It is in order to obviate such difficulties that the apparatus illustrated herewith, from the Revue Industrielle, has been devised. Instead of the jaws being arranged as usual, the movable one is here made to advance toward and recede from the stationary one by means of a crank and connecting rod mechanism established at the upper part. This jaw oscillates around a stud at the bottom.

The engraving shows that the stationary jaw, AB, is jointed to the lower part of the frame, which is much lighter than usual. The latter, in fact, consists of a cast iron base prolonged by thick steel plates between which is formed the crushing chamber, and which are united by cross braces of I section. Upon these cheeks are bolted, at the upper part, the bearings of the driving shaft, which is provided with two fly wheels. This shaft, C, which is of steel, carries two connecting rods, g, which actuate the movable jaw. All the joints are protected against dust.



THE JELMAN-WEPP CRUSHER.

The grooved facings, A and E, of these jaws are mounted in a simple and firm manner, and in such a way that they can be quickly removed and replaced. They are cut slopingly at the extremities so that they may be held by a simple tightening of wedges, F, through a bolt, between shoulders of corresponding obliquity.

In order to modify the size of the fragments of the substance crushed, the wedge, H, is acted upon by

means of a screw in such a way as to vary the distance between the stationary jaw and the movable one considered in the initial position of its motion. A machine of this kind presenting an opening of 8 by 12 inches occupies a space of 5·5 by 2·25 feet, and, at a velocity of 190 revolutions a minute, crushes from 3 to 5 tons of quartz an hour.

THE SOLEMN APES OF INDO-CHINA.

The monkey house of the Jardin des Plantes, of Paris, has been peopled in recent years by the most varied guests. There have been seen therein successively or simultaneously alongside of the Lemuridæ or false monkeys two orang-outangs, several chimpanzees and some ordinary monkeys of varied types. Among the latter there were not long ago two very pretty animals that had been brought from Tonkin by Count de Barthelemy, who had just made a trip through French Indo-China. These monkeys belonged to the species that Buffon described under the name of douc, and that Frederic Cuvier later on arranged, with the entelle and other Asiatic monkeys, in the genus Semnopithecus. The Semnopitheci, the name of which, derived from Greek, signifies "venerable" or "solemn monkeys," take the place in southern Asia of the Cercopitheci or guenons, which belong to the African continent. They are characterized by a long, slender body and a long, slender, straight tail, and by the absence of those cheek

SOLEMN APES IN THE JARDIN DES PLANTES, PARIS.

pouches in which other monkeys accumulate a certain quantity of food; but their stomach possesses several compartments that slightly recall the subdivisions of the stomach of the ruminants, and this arrangement is evidently in keeping with the diet of these animals, which feed upon fruits, leaves and buds.

In some of the Semnopitheci, for which the genus Nasica has been erected, the nose assumes an exaggerated development. In others, which M. Milne-Edwards has named the Rhinopitheci, this organ is flattened at the base and turned up at the extremity; but in the Semnopitheci, properly so called, it remains flattened rather than projecting in the center. The face is smooth, now black and wrinkled, and now tinged with bright colors during the animal's life, and is surrounded with bushy hair, which is often elongated after the manner of eyebrows and side and chin whiskers, and which, upon the top of the head, has a tendency to rise in a tuft. The ears, which are very small, are thus completely concealed. The body, the tail and the limbs up to their extremities (with the exception of the palmar surface) are likewise covered with a thick and silky fur, of which the colors are sometimes modest and well blended and sometimes bright and showy. Thus in the Semnopithecus entellus, of Bengal, the coat is of a yellowish gray, passing to white upon the lower parts and to fawn color upon the other portions of the body. In the S. maurus or budeng of the Javanese it is of a golden yellow in the young and of a gray shaded with black, brown and fawn color in the adult. In the S. nigripes of Cochin China gray is the dominant tint of the coat, but the chin and cheeks are of a nearly pure white, while the extremities of the limbs look as if they had been dipped into ink. On the contrary, in the S. nemæus, the hands and forearms look as if they were covered with white mittens and the legs with maroon colored gaiters that stand out conspicuously from the other parts of the costume. In the last mentioned species all the upper parts of the body are of a gray color finely pencilled with black, with the exception of the rump, which is of an immaculate white, as is also the tail. A blackish stripe transversely intersecting the loins separates the two colors, black and gray. The latter shade extends to the top of the head and is limited upon the forehead by a blackish band. Long side and chin whiskers adorn the face, which is of a livid yellow. Finally, upon the throat we remark a sort of maroon colored gorget which connects on each side with a black stripe that extends over the shoulder. Some idea of the distribution of the colors of the douc, if not of their richness, may be obtained from the accompanying figure, which reproduces the traits of the two individuals that were presented to the museum by Count de Barthelemy.

These two monkeys were captured upon a wooded mountain that overlooks the Bay of Tourane. What is a curious thing is that this species must be absolutely confined to this region, where it had already been observed some sixty years ago by F. Eydoux, one of the naturalists attached to the "Favorite" expedition. At this epoch the doucs lived in numerous troops in the forests bordering the coast, and, not being disturbed by the aborigines, freely approached the habitations. Eydoux brought home two specimens of them, which he obtained under the following circumstances. An adult female and mother was first killed. Her little one, which was following close in her footsteps, struck by the same shot, but merely wounded, threw itself upon the mother in uttering piercing cries, brought forth both by the loss that it had just suffered and the pain that it experienced. The young douc was preserved for several days on board of the corvette, but soon died, the wounds that it had received having completely paralyzed the hind limbs.

The doucs do not endure captivity very well, and in certain cases, it would seem, become so melancholy at the loss of their liberty that they put an end to their life by strangling themselves or allowing themselves to die of starvation.

Count de Barthelemy lost in this way a superb male of great stature, which committed suicide in its cage. "The food of the doucs," says this traveler, "consists in a wild state of the fruit of the mastic tree and of other mountain plants. They are very fond of bananas, and I found it possible to accustom them to the use of bread during a great part of the journey." They drink a large quantity of water, and Count de Barthelemy attributes the spleen with which the douc is afflicted in captivity partly to the want of this liquid in a limpid and running state.

The blackfooted Semnopithecus (S. nigripes), to which we have alluded above, is found in another region of Indo-China, in the forests that border the lower part of the Mekong. This species, the discovery of which we owe to M. R. Germain, a French traveler, exhibits in the coloration of its face a peculiarity to which attention has recently been called by M. Beck, superintendent of native affairs. Each of the eyes is surrounded with a wide yellow circle that detaches itself from the slate color of the rest of the face in such a way that the animal seems to wear gold spectacles.

Finally, Indo-China possesses a third species of Semnopithecus, which, like the preceding, was discovered by M. Germain and described by M. Milne-Edwards under the name of Semnopithecus Germani. Its coat is of a dark gray, verging upon black upon the hands and feet and tail, and it has a black face.—La Nature.

EXPLORING A GREAT AUSTRALIAN DESERT.

The Carnegie expedition, which for thirteen months has been exploring the great desert of West Australia, has returned, says The New York Sun. Its journey extended from the well known mining town of Coolgardie, in the south-central part of the province, to the Kimberley gold mines in the northwest of the continent. It traversed considerable territory not previously visited and made some interesting discoveries.

Mr. Carnegie fitted out and commanded the expedition. He had three white assistants, a black boy, eight baggage camels, and provisions for six months. He started on July 9, 1896. About two hundred miles north of Coolgardie he entered a part of the Great Victoria Desert which no white man had seen before. It was a most desolate region, with no grass or other forage for the camels. There were only spinifex, acacia, and other dwarf shrubs in the way of vegetation. After fourteen days' traveling across this desert, the water supply became so far reduced that only half a pint a day was allowed for each person. At last, when only two gallons of water remained, the party met some natives, one of whom they caught and finally induced to pilot them to a water source. He led them four miles away to a waterhole of a remarkable character.

It was, in fact, a limestone cave of considerable extent. At the surface was an opening three feet in diameter, against which rested one end of a stout pole about twenty feet long, the other end resting on the floor of the cave. The natives had placed it there to facilitate their entrance and exit. Down the pole the white men scrambled and found themselves in a chamber of considerable size, from which they entered a passage, with sloping floor, about twenty-five feet in length and so low that they had to make their way on hands and knees. At the other end of the passage they reached a fine brook with plenty of clear, cold water that gave the expedition an ample supply. Mr. Carnegie named this water source "Empress Soak."

Around the cave there were good fodder for the camels, and so they rested there for three days. Then they went on over the desert to the northeast, and when near Mount Worsnop they were happy to run across a lagoon with fresh water upon which numerous wild ducks and other water fowl were swimming. The lagoon had a circumference of about a mile and the water was from a foot and a half to five feet in depth. The borders showed a fine growth of mulga, acacia, and bloodwood trees, and there was a grass covered meadow which gave much delight to the camels. Mr. Carnegie named this water source Woodhouse Lagoon, and at this inviting spot they remained for three days.

Then they pushed north again over the ironstone, on which a considerable growth of the mulga tree flourishes. They had an ample water supply, and so did not suffer during the eight days in which they saw no water. At the end of this time they came to some wells used by the natives, around which grew plenty of waterbush, which was highly relished by the camels. Further north, on the west side of the Alfred and Maria range, they found another small waterhole which had been recently visited by the natives. All these discoveries of water in one of the most frightful deserts of the world are interesting, because they were never known before. In the next ten days they found some areas that suggested marsh land, but yielded very little water. Their supply became so short at last that they tried the experiment of digging through the sand, a difficult undertaking, which occupied three days, and they were rewarded at last by only ten gallons of very dirty water after digging to a depth of thirty feet. They had met a number of natives, and for a few hours they kept an old woman in their camp, in the hope that she would reveal the source of their water supply. She would not give them a particle of information, and at last they let her go.

The scarcity of water and fodder continued until the expedition had traveled as far north as Sturt Creek. For days they had seen nothing but high sand hills, spinifex and ironstone. Not until they reached 19° 20′ south latitude was there a change for the better. They came at last to a region with a thick growth of scrub, where, however, they had the misfortune to lose three of their camels that had eaten poisonous plants. Their troubles were not over even when they reached the well-watered and grassy district between Christmas Creek and the Margaret River, for here they lost Mr. Charles Stansmore, who accidentally shot himself as he was getting ready to fire at a kangaroo. Not long after they reached the Kimberley gold fields, where they replenished their supplies.

On the return journey they traveled, for the most part, a little east of their northern track, to see if they could find a good route with sufficient grass to be used for driving cattle from the Kimberley district southward to the Coolgardie gold fields. They did not succeed in finding such a route, and a part of the region, if not more desolate than that along their northern road, was more difficult to cross, for they were constantly ascending and descending high sand hills. In a distance of ten miles they crossed eighty-six of these hills.

The chief result of their explorations is the evidence they obtained that most of the central part of West Australia offers no prospect of good grazing lands or mineral resources. In the center of this great waste they found a part of a saddle and an iron tent pin of patterns that have not been used for many years,

and they believe that these objects are relics of the Leichardt expedition, which nearly half a century ago was swallowed up in the desert, and to this day nothing has been heard of its fate.

REMARKS ON RHUS TOXICODENDRON.

By LOUIS F. FRANK, M.D.

ABOUT two months ago my attention was drawn to an article written by Mr. Bernhard Ziehn, the well-known musician of Chicago, likewise an authority on botany, in which the earnest consideration of the city authorities was called to the fact of the existence and flourishing of the Rhus toxicodendron in the various parks of Chicago, advocating radical measures against the alarming condition.

In Lincoln Park, in the neighborhood of populated streets, Mr. Ziehn localized seven wild ivy plants, one of them with at least twenty roots encircling an oak tree, thirty feet in height, sending its shoots to the very top of the tree. In Washington Park, near its northern entrance, he found a tree, twelve feet in height, loaded with the poisonous fruit, and a shrub with a trunk the size of an arm. A similar condition of affairs was discovered in the Jefferson, Union, Garfield and Douglass Parks of Chicago, and in all places north of Chicago toward Evanston. The agricultural department at Washington, learning of the efforts of Mr. Ziehn, requested him to continue the same and keep it informed as to the progress made. Moreover, as Mr. Ziehn during a visit to Milwaukee discovered the plant in "The Ravine" and other places in Lake Park, he asked my co-operation in the matter, which I, convinced of the importance of the subject, decided to bring before the profession. Not a year has passed but I have been called upon to treat a number of cases of dermatitis caused by one or other variety of the Rhus species, and no doubt it has been not an unfrequent occurrence in the experience of the general practitioner.

Dr. White, of Boston, in a review of three hundred and sixty cases of dermatitis treated in his clinic during the past two years, has found thirty, or nearly ten per cent. of them, to have been caused by the so-called wild ivy.

It is well known that the vegetable kingdom furnishes many substances which, when in contact with the skin, occasion irritation and more or less severe inflammation. According to the virulence or concentration of the poison and the susceptibility of the skin, the lesion will be erythematous, vesicular, pustular, or bullous in character. Among these plants may be mentioned nettle, mezereon, arnica, common parsnip, witch hazel, hop, horn beam, and, above all, the species Rhus toxicodendron and Rhus venenata, a genus of the common sumac. The former, Rhus toxicodendron, by earlier botanists and more properly called Rhus radicans (Fig. 1), is a vine of very common occurrence, running over stone fences and along the borders of woods, in ravines or climbing on to trees to a considerable height and attaching itself to these surfaces by lateral rootlets. It is popularly known as poison ivy, poison vine, poison oak, mercury, and is found abundantly throughout the United States east of the Great Plains, and in the arid regions of the West, with the exception of California. It is generally a climbing vine, but if no support is at hand, it either trails along the ground or sends up short vertical shoots. With the exception of one near Western relative, which is almost as poisonous, there are no other plants which resemble it closely, excepting the non-poisonous box elder, and this only in its seedling stage. The Virginia creeper, also non-poisonous, is sometimes mistaken for

FIG. 1.—POISON IVY (RHUS RADICANS).

the poison ivy, but is easily distinguished by its having five instead of three leaflets.

The second variety, Rhus vernix, or poison sumac (Fig. 2), also commonly known as poison dogwood, poison ash and poison elder, is found growing in swamps from Florida to Canada and westward to the Mississippi Valley. It is a shrub or small tree, six to eighteen feet in height, with long pinnate leaves, having from seven to thirteen smoothly polished leaflets.

The third variety, of near resemblance to the first named Rhus radicans, is known as Rhus diversiloba, or poison oak (Fig. 3), and is found only throughout the Pacific coast from Lower California to Canada and northward. The leaves differ in size as well as in shape from those of the poison ivy.

The first and second varieties, therefore, Rhus radicans or toxicodendron and Rhus vernix, are of special interest to us, as the same are indigenous to Wisconsin.

It has generally been accepted up to to-day that the poisonous irritant in the various species of the Rhus family was due to an active principle, consisting in a volatile acid, called toxicodendric acid. This was found in 1865 by John M. Maisch, of Philadelphia, and is to-day regarded in the United States Dispensatory as the active principle of Rhus. During the last three years, however, Dr. Franz Pfaff, of the pharmacological laboratory of the Harvard Medical School, has made a series of very interesting analyses and experiments, which not only criticise the imperfect manner and non-scientific results of Maisch's investigations, but also seem to prove that the principle is not a volatile acid, as thus far recognized, but consists of an oil, for which Pfaff proposes the name toxicodendrol. This poisonous oil has been found in all parts of the plant—in the stems, branches, roots, leaves and fruit

FIG. 2.—POISON SUMAC (RHUS VERNIX).

—its amount, however, varying, the fruit containing 3·6 per cent., the leaves 3·3 per cent. and the stems and branches only 1·6 per cent. The oil is easily soluble in alcohol, ether, benzol, chloroform, etc., but is insoluble in water. The effect of the isolated oil upon the human skin is described in the second number, 1897, of The Journal of Experimental Medicine, the experiments producing a clear, clinical picture of a dermatitis venenata.

I communicated with Dr. Pfaff, and he kindly forwarded to me a specimen of the toxicodendrol in its crude state, which was extracted from a fresh lot of Rhus venenata and had not yet been tested. He informs me that the pure oil is of a pale yellow color, exceedingly poisonous—to such an extent that the smallest quantity of the oil, unable to be detected by the unaided eye, would cause all the characteristic lesions of wild ivy poisoning. It seems to me that the specimen sent to me is incapable of producing a dermatitis, as I have applied it thoroughly on my arm on two different occasions, likewise on the forearm of my druggist, without inflammatory result. Possibly neither of us is susceptible to the poison, and further experiments are necessary to prove its efficiency. However, the free purified toxicodendrol has in Dr. Pfaff's hands never failed to produce an irritant action.

The active principle, according to Dr. Pfaff, being a non-volatile substance, the question arises as to the commonly accepted idea that poisoning may occur without actual contact with the poisonous plants. Pfaff disputes this view, believing that actual contact with the poisonous oil is essential to produce the skin lesions, rendered extremely easy by the great activity of the poison and the latent period of development. None of the hundreds of persons that passed through his laboratory during the time that these plants were handled were poisoned unless they came into actual contact with the plant or the free oil. Nevertheless, the popular opinion prevails that the actual touching of the plant is not necessary to produce the eruptions; that the emanations at night time are particularly dangerous; and it has been maintained that persons may be poisoned by the exhalations into the room while the wood is burning in the fire.

I have read of several reports of cases in which the poisoning was produced by a peculiar Japanese lacquer, made from the Rhus vernicifera, not only in those actually engaged in lacquer work, but in those who live or sleep in rooms in which fresh lacquered goods are drying. Especially children, after a night's rest in a room in which a newly purchased chest of drawers has been placed, exhibit symptoms of poisoning the next morning.

The question is still an open one, and scientific experiments must be resorted to in order to decide it satisfactorily. Personally, I am inclined to believe that a great many of the above cited cases are of the "hearsay" order and cannot be accepted as undoubted evidence. The poison of Rhus toxicodendron may be communicated by direct contact with parts of the plant, or indirectly from one person affected to the other. The former method includes the great majority of all cases. The following two cases may illustrate the manner in which one person may communicate the poison to another.

The first is described in an article written by Dr. White,* reporting a fatal result in consequence of the poison. "A servant boy, being insusceptible to ivy poisoning, had been employed in pulling up all the vines of that plant found growing in the grounds about the house. When his task was finished, he was made to wash his hands thoroughly with hot water and soap and afterward with vinegar. In the afternoon he was allowed to take the six year old child of the family to a pond for a bath. Having stripped the child, he immersed him, holding him with his hands under the armpits, and afterward rubbed his back with his open palm. After three days deep ulcers formed under the armpits and every part touched by the hands showed the characteristic marks of wild ivy poisoning."

Another case, reported by Dr. Cantrell,* shows how the poison was conveyed to the umbilical region of a female patient of the Philadelphia Hospital, a vesicular and bullous eruption having a radius of five inches, œdematous and covered with a yellowish brown discharge, appearing three days after confinement. Upon inquiry it was learned that on the day of birth the attending nurse, taking a stroll through an adjacent cemetery, had gathered some leaves, bringing a number back with her. The ivy poison was in all probability conveyed to the patient during the time of dressing, although the hands of the nurse had been previously washed several times with soap and water. Her hands at that time showing no signs of infection, became affected two days later, at about the same time the eruption appeared on the abdomen of the patient.

A third case is mentioned by Dr. Busey,† in which a family, consisting of both parents and an infant, was affected at the same time, the mother having a severe attack quite general over the whole body, the husband a similar eruption on both hands and the infant a slight one about the mouth and chin. A week previous to the appearance of the eruption the husband and wife had passed an afternoon at a picnic and he had fastened his horse to a bush covered with a vine, the character of which he had not observed. The wife did not approach the plant and the child had been left at home.

Dr. J. B. Walker‡ reports the fourth case I have found in the literature of poisoning by indirect contact. "A lady spent the night with her sister, whose husband was obliged to be absent on business. The husband had been poisoned about the head and neck with ivy a few days before leaving home. The pillow case on which he slept was not changed, and his sister-in-law, using it, became poisoned about the face and neck in consequence thereof."

The disease usually begins on the hands, the inner surfaces of the digits being first affected, whence it spreads on the dorsal and later on the palmar surfaces. From the hands it is usually communicated to the face and the genitalia, and may from there come in contact with the entire body. The eruption generally appears in an erythematous form, accompanied by vesicles, pustules and even abscesses, and it is attended with more or less œdema, swelling, heat and itching. The serous infiltration may be so great as to occasion great disfigurement, especially of the hands, arms and genitalia. The vesicles are usually small and often develop into pustules, which may rupture, the discharge drying into yellowish crusts.

The remedies that have been recommended for the treatment of Rhus poisoning are almost as numerous as those for eczema. Among the domestic remedies vinegar and solutions of saleratus and carbonate of sodium are widely and highly esteemed. I noticed a glowing account of the efficiency and virtue of buttermilk and pounded crabs in Japan as a remedial agent. Among the medicinal remedies the following have been advocated: Astringent lotion of acetate of lead, sulphate of zinc, alkaline solution of lime water, ammonia and hyposulphite of sodium, decoctions of white and black oak bark, Virginia snake root, chestnut leaves, solutions of the fluid extract of grindelia robusta, calomel (black wash) and sublimate, emulsion of bromine, dusting powders and an array of ointments.

The use of dusting powders, oxide of zinc, starch, magnesia, talcum, etc., I cannot recommend as practicable. Certainly, they produce a rapid cessation of the serous discharge and a drying up of the same, but mingled with the pathological and normal secretions of the skin a layer of putrefying, decomposing crusts is

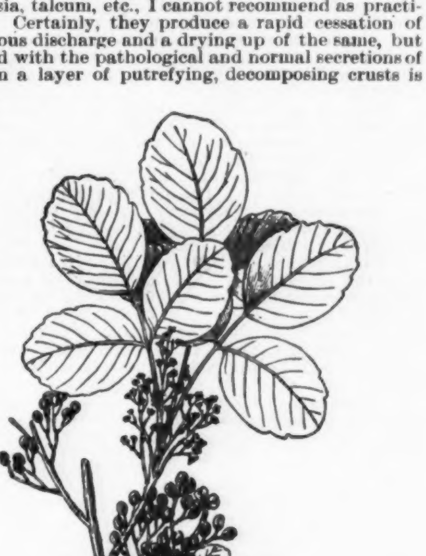


FIG. 3.—POISON OAK (RHUS DIVERSILOBA).

formed, which tends to increase the inflammation. The same may be said of applications of ointment or plasters, as fats in the acute stages of a dermatitis are often not well borne; ointments of lead are especially bad, whereas Lassar's salicylic paste rarely is found to irritate the lesion. The treatment of any toxic dermatitis must be carried out on the same basis as that of eczema in its acute or subacute state, and the essential principle which ought to guide us in its successful treatment is antisepsis and asepsis. We know that a local infection has taken place; the poison has been absorbed by the skin, causing a pathological lesion, which is attended

* New York Medical Journal, 1873.

* Medical News, 1891.

† American Journal of the Medical Sciences, vol. xvii.

‡ Medical News, 1891.

by inflammation and its sequelæ—exudations, crusts and scales. These disease products are usually still more contaminated by external irritants, as salves, oils and infected dressings. Plainly there seems but one thing to do: to follow out the principles of modern surgery, viz., to remove all products of infection and render the diseased part aseptic, and naturally the first indication is a cleansing bath with soap and water. And, strange as it may seem, what has been imperative in surgery has hitherto been but reluctantly followed in dermatology, the statement of Pindar, "Water is truly the best," being ignored. It is a popular notion, for instance, that infants affected with intertrigo and its sequelæ, dermatitis and eczema, must be prohibited from bathing, and strangely enough this view is shared and supported by many physicians. It is hard to believe that any one can sanction the presence of effete material consisting of the products of the perspiratory and sudoriparous glands, in the process of decomposition, to remain and act as inflammatory irritants. Basing on this simple and rational theoretical view, I have treated in the above manner all cases of dermatitis incited by external irritants, with far better success than by my former methods following the routine treatment. The bath is followed by applications of soothing antiseptic emulsions containing calamine, glycerin, and lime water, and so forth.

Having concluded the clinical aspect of the subject, it remains for me to speak of the importance of the prophylactic and legal measures to be taken in order to counteract and eradicate the harmful disease-producing plant. Although the name wild ivy is familiar to almost everyone, the plant is so little recognized, as a rule, that contagion takes place when it might be easily avoided if the plant were better known. In this connection also I wish to mention the necessity of knowing and recognizing all poisonous plants indigenous to our soil, such as the datura stramonium, hyoscyamus, digitalis, lobelia, solanum nigrum, conium, aconite, hellebore, ricinus, clematis, colchicum, the buttercup, water hemlock, daffodil, narcissus and varieties of fungi.

This important knowledge should be imparted in our schools, and I well remember seeing during my stay in Germany charts in the schoolroom, illustrating in color the various poisonous plants of that section of the country, in order to familiarize the children with their characteristic appearances. Furthermore, the teachers would accompany their classes into the woods and meadows, calling their attention to the species and properties of plants by intuitive instruction.

The number of deaths which occur every year from incautious eating of poisonous plants, as described in a report of the agricultural department, is very large. The victims are usually children, who pluck and eat all sorts of attractive looking berries and other parts of plants. A special commission was appointed about three years ago by the bureau of agriculture to investigate poisonous plants and enlighten the public as to their danger.

According to a government report on health, 1884, a peculiar disease in children, characterized by extreme weakness, vomiting, fall in bodily temperature, dry tongue and constipation, is said to be prevalent in some Western States, which is supposed to be produced by cows affected with the "trembles," caused by feeding on wild ivy.

In my efforts of investigating this subject as to its legal aspect I was very kindly assisted by Dr. U. O. B. Wingate, secretary of the Wisconsin State board of health, and I take this occasion to thank him for the interest he has shown. There exists at present in this State a law amended at the last session of the legislature, known as chapter 82, 1897, pertaining to noxious weeds, not, however, naming the Rhus plant in particular. Dr. Wingate, in order to ascertain whether such law would include the plant in question, kindly furnished me with the opinion of the attorney-general as to the law on this point, viz.:

"Relative to the destruction of noxious weeds, it is my judgment that any person has the right to destroy the weeds designated as noxious, when found in public parks and other public places.

"The law provides that the persons in control of lands shall be given notice of the presence thereon of noxious weeds, and they must be destroyed within a certain specified time thereafter, or the persons so notified shall be subject to penalty.

"Notwithstanding this provision, it seems to me that the poisonous weeds which may be found and whose presence may be a menace to public health, as indicated by your letter, may be destroyed by any person, for the reason that they would be deemed by law to be public nuisances, and as such subject to immediate abatement by any person knowing their character. The reason for the destruction of these by persons having knowledge of their character is to prevent the destruction of vegetation which is not noxious in its character, and those who destroy noxious weeds must be careful and not injure surrounding vegetation, for by so doing they would render themselves liable.

"It certainly is within the province of a board of health forthwith to destroy, or order destroyed, such weeds as may be dangerous to the public health, and this right it has in its general right to take such measures and use such precautions as may be necessary to protect the health of the people."

The information above given makes any commentary unnecessary and clearly places all right of jurisdiction in the hands of the authorities on health. Active measures taken in this respect and a publication of such facts cannot fail to be of invaluable service to the many thousand persons who are brought into almost daily contact with the plants, and cannot be too highly recommended and demanded.—Medical Record.

The growth of the New Zealand frozen meat trade to Great Britain is strikingly shown in the official statistics for the six months ended December 31 last. In the half year ended June 30, the total shipments were 43,593,102 pounds of mutton and 2,129,140 pounds of beef; but for the last half year the totals were 60,030,521 pounds of mutton and 6,111,184 pounds of beef. The sixteen principal refrigerating stores within the metropolitan area are capable of holding 1,114,000 carcasses of sheep, and those in the provinces, of which Liverpool, Glasgow, Manchester, Bristol and Hull are the most important, have a capacity equal to 975,000 carcasses, while the stores in course of erection will provide for an additional 435,000 carcasses.

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TABLE OF CONTENTS.